18 December 1980

NOTE FOR: The Director

Stan:

Attached is the proposal concerning the establishment of an "information institution" of some sort. This is the first cut and was prepared by an ADP specialist (his biography is also attached) and lacks some of the human warmth that I am working to breathe into it. The way I see it, the institute would be humans getting control and organizing the coordination of the automated information systems which seem destined to control our lives. The proposal needs more examples of the people problems we would propose to solve and I am working on that.

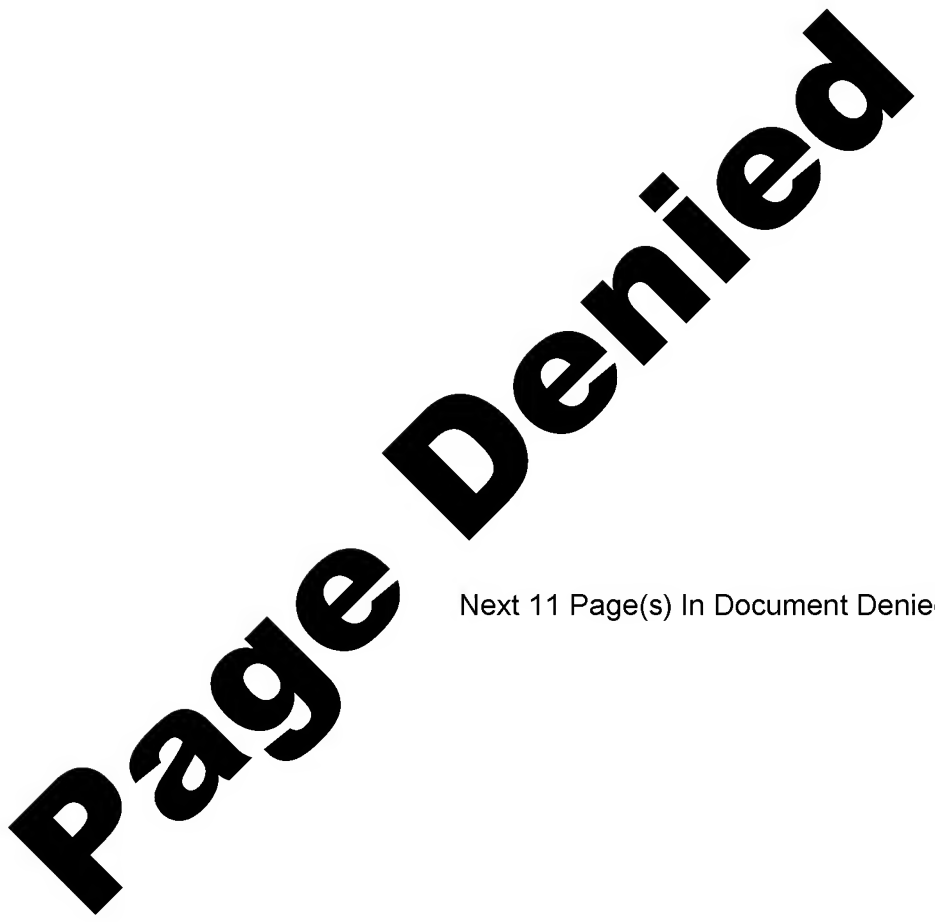
The attachments to the proposal as you will see are other studies along this line and some proposed legislation to establish an Institute for Information, Policy and Research to address national information policy issues. I am told the bill is going nowhere leaving the way clear for the private foundation to undertake the same activity.

In any case, I hope you will take a look on sunny Maui and perhaps we can discuss when you return.

Herbert E. Hetu
Director of Public Affairs

Attachment: a/s

STAT



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THE INFORMATION SCIENCE AND TECHNOLOGY ACT OF 1980

The SPEAKER pro tempore. Under a previous order of the House, the gentleman from California (Mr. BROWN) is recognized for 5 minutes.

● Mr. BROWN of California. Mr. Speaker, I am introducing today a bill entitled "The Information Science and Technology Act of 1980." By so doing I intend to emphasize my interest in addressing the serious challenges presented to policymakers by the explosive growth of microelectronics and telecommunications technologies.

Rapid advances in these fields, and the convergence of computers and telecommunications, have created new opportunities for economic growth, increased export markets, and gains in productivity, and will permit increased public access to all kinds of useful information. At the same time, these advances have important implications for the size and structure of the future workforce, for the evolution of educational institutions, for personal privacy and civil liberties, and for many other concerns central to our personal and societal values. If we are to take advantage of the opportunities made possible by the new information technologies and minimize potential negative impacts, our social and governmental institutions must come to grips with the important policy questions raised by these scientific and technological developments.

Mr. Speaker, information and communications technologies are still in a stage of rapid development, and this development will be a dominant feature of the coming decade. The bill which I am introducing establishes on institute for information policy and research, with a lifespan of 10 years. I view the institute as a transitional mechanism to facilitate our Nation's evolution toward a society based increasingly on information products and services. This mechanism would make possible cooperative planning among the Federal Government, business, educational interests, and State and local governments, for the productive and humane use of information technology in the workplace, school, and home.

I believe that the independence of the institute would allow it a broad and integrated perspective on such issues as institutional structure and regulatory policy, a perspective not subject to the political or bureaucratic constraints on the several dispersed agencies now concerned with information issues. As structured in this legislation, the institute would not be engaged in hardware research and development, nor would it have any regulatory authority. Its primary purpose would be to provide a focal point for policy research and analysis and a forum for consideration of the information interests of Government, business, and education.

I regard the bill in its present form as a working draft, and I welcome comments and suggestions from interested individuals and organizations. After consideration of suggested changes, I hope to introduce a revised version early in the 97th Congress. At that time I look forward to entering into more extensive discussion of the fundamental importance of this issue, and I will present in detail the case for pursuing this particular legislative approach.

Although the legislation I am introducing was developed as an outgrowth of work in the Science and Technology Committee, it is clear that a phenomenon as broad in its impact as the "information revolution" cannot respect committee jurisdictions. The results of new technological developments are of concern to every Member of this House, and the impacts I have alluded to obviously extend to the responsibilities, extertise, and interest of numerous other committees. I am not distressed by this shared interest and responsibility. In fact, a concerted effort is needed, and I look forward to working with other Members and other committees to meet the legislative challenges presented by these exciting new advances. I realize I am not alone or unique in sensing the momentous changes we are facing as we move into an information society. I hope that those of our colleagues who share with me the sense of excitement and awe over the technological changes we are witnessing will join in a cooperative network dedicated to mobilizing the capabilities of the new information technology for the benefit of society.●

The SPEAKER pro tempore. Under a previous order of the House, the gentleman from Ohio (Mr. VANIK) is recognized for 5 minutes.

[Mr. VANIK addressed the House. His remarks will appear hereafter in the Extensions of Remarks.]

PERSONAL EXPLANATION

The SPEAKER pro tempore. Under a previous order of the House, the gentleman from Washington (Mr. SWIFT) is recognized for 5 minutes.

● Mr. SWIFT. Mr. Speaker, I noted with surprise that the record listed me as voting in favor of the Brooks amendment to the revenue-sharing bill. This would have deleted the revenue-sharing authorization for State governments. Fortunately it was rejected by a vote of 65 to 306.

While I have voted against State revenue sharing in the past due to large surpluses that the State treasuries have boasted, I had determined to vote for it this time. The surpluses have largely vanished and I fear that curtailments in State revenue sharing at a time of reduced or nonexistent surpluses will encourage State governments to reduce assistance to local governments, which already face almost impossible budget crunches.

However, in double checking, I found that I was indeed recorded as voting for the amendment. I wish to state for the record that this vote was inadvertent and that I am pleased that the amendment was defeated 65 to 306.

REDUCTIONS SHOULD BEGIN WITH THE CONGRESS

The SPEAKER pro tempore. Under a previous order of the House, the gentleman from California (Mr. PANETTA) is recognized for 5 minutes.

● Mr. PANETTA. Mr. Speaker, one of the serious internal problems Congress has faced in recent years is the proliferation of staff on Capitol Hill. The House and Senate have become major bureaucracies, and the cost of running Congress has skyrocketed.

Most of us have heard this stated before, but I think the facts are worth repeating. In the last 20 years, there has been a tenfold increase in the cost of running Congress. The number of staff, meanwhile, has virtually tripled. While inflation is to blame for the part of the cost increase and a rise in the Nation's population creates a need for additional personnel, the actual increases in costs and staff far outstrip what might be considered a reasonable expansion.

I believe that Congress is making an attempt to cut costs, or at least to slow down the increase. The appropriations bill for the legislative branch for fiscal year 1981, as passed by the House in July, represents an increase from 1980 of only 2½ percent. Given the rate of inflation, this is a good start.

However, at a time when the cost of all Government is soaring out of control and inflation appears to be on the upswing once again, Congress must set an example of genuine austerity. In the other body, the future majority leader has indicated that he will attempt to reduce committee expenses, largely through staff cuts, by 10 percent during the 97th Congress. I believe the House of Representatives should set a similar goal.

Of course, the party reversal in the other body will permit the new majority to achieve overall staff cuts while actually increasing its own patronage and hiring powers substantially. Thus, while I am pleased to see that there will be reductions, the level of actual sacrifice should not be overestimated.

By the same token, achieving cuts in the House will not be easy; great sacrifice will be required. However, I think major reductions can be achieved, particularly in committee staffs. In my view, and, I think, in the view of most individual Members, the committee staffs have become bloated with unneeded personnel. This does not mean that committee employees are not quality workers and individuals. What it means is that many of them simply are not necessary to the smooth operation of the committees and the Congress. I believe that a commitment to austerity in the committees and in other support staff could produce substantial reductions.

As I have said, the other body intends to achieve a 10-percent reduction in 1981. Given the vastly different situation in the House, it would be extremely difficult to make identical cuts here. Nevertheless, if the proper effort is made, the House should be able to achieve a 10-percent reduction in personnel costs during the 2 years of the 97th Congress.

96TH CONGRESS
2D SESSION

H. R. 8395

To maintain and enhance the United States leadership in information science and technology by establishing an Institute for Information Policy and Research to address national information policy issues; to provide a forum for the interaction of government, industry and commerce, and educational interests in the formulation of national information policy options; to provide a focus and mechanism for planning and coordinating Federal research and development activities related to information science and technology; and to amend the National Science and Technology Policy, Organization, and Priorities Act of 1976 to create a new Division of Scientific and Technical Information.

IN THE HOUSE OF REPRESENTATIVES

DECEMBER 1, 1980

Mr. BROWN of California introduced the following bill; which was referred to the Committee on Science and Technology

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A BILL

To maintain and enhance the United States leadership in information science and technology by establishing an Institute for Information Policy and Research to address national information policy issues; to provide a forum for the interaction of government, industry and commerce, and educational interests in the formulation of national information policy options; to provide a focus and mechanism for planning and coordinating Federal research and development activities related to information science and technology; and to amend

the National Science and Technology Policy, Organization, and Priorities Act of 1976 to create a new Division of Scientific and Technical Information.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SHORT TITLE

SECTION 1. This Act may be cited as the "Information Science and Technology Act of 1980".

FINDINGS

SEC. 2. The Congress finds and declares that—

(1) advances in microelectronics and telecommunications have created opportunities for greater productivity, more efficient use of energy, increased exports, and access by individuals and institutions to a great diversity of information and educational resources;

(2) the conduct of scientific research and development activities would be benefited by improved access to relevant and timely information;

(3) new developments in information technology afford an opportunity, for the efficient collection, storage, retrieval, and dissemination of scientific and technical information, which is critical to public and private efforts to apply new knowledge;

(4) international information issues, including transborder data flows and increased foreign competi-

have important implications for foreign policy and national economic well-being;

(5) Federal research, development, and policy activities concerned with information are uncoordinated and fragmented throughout numerous agencies, and current efforts toward resolving information issues are limited by the inability to consider the overall impacts on the many sectors involved;

(6) no comprehensive national effort has been undertaken to address the issues arising from the rapid development of information technology and telecommunications, or to articulate national policy in the light of this development;

(7) information services provided by the private sector constitute an important and rapidly expanding part of the information community, yet no effective means currently exists to bring together public and private interests to discuss national information concerns in a cooperative forum; and

(8) the Nation's ability to exploit technological advances to achieve economic progress, to compete in world information markets, and to prepare citizens for participation in the information society is imperiled by the lack of a coordinated analysis of the implications of information technology.

PURPOSE

SEC. 3. It is the purpose of this Act—

(1) to promote and facilitate the conduct of scientific research and development through the use of modern information technologies;

(2) to provide a forum for considering the information concerns of government, industry and commerce, educational interests, and the public;

(3) to investigate and provide assessments of current and projected future developments in information science and technology, and of potential applications and their impacts, to serve as a basis for policy determination in information-related issues; and

(4) to conduct and manage research, development, and analysis in information science and technology in support of the objectives described in paragraphs (1), (2), and (3).

DEFINITIONS

SEC. 4. As used in this Act—

(1) the term "Institute" means the Institute for Information Policy and Research established by section 101(a);

(2) the term "Board" means the National Information Science and Technology Board established by section 101(b)(1);

(3) the term "Director" means the Director of the Institute for Information Policy and Research, as provided for in section 101(b)(2);

(4) the term "information science" means the knowledge of how information is organized and transferred; and

(5) the term "information technology" means the tools used to collect, process, store, retrieve, and transmit data and information, including in particular computer-based systems.

TITLE I—INSTITUTE FOR INFORMATION POLICY AND RESEARCH

ESTABLISHMENT OF THE INSTITUTE

SEC. 101. (a) There is hereby established in the executive branch of the Federal Government an Institute for Information Policy and Research.

(b) There are hereby established in the Institute—

(1) a National Information Science and Technology Board, to function in accordance with section 105; and

(2) an Office of the Director of the Institute, to function in accordance with section 106.

(c) The Institute shall be located at a site within the United States to be determined by the Board, and shall be

administered by the Board in accordance with existing Federal laws.

(d) In addition to the Director, the Institute shall have such other officers and employees as the Board may determine to be necessary or appropriate.

MEMBERSHIP IN THE INSTITUTE

SEC. 102. (a) Organizations and institutions with a significant interest in information policy may become members of the Institute, under such conditions as the Board may determine under section 104. No membership or any right, privilege, or interest incident thereto may be assigned or transferred by any member.

(b) Each member of the Institute shall be represented by a designated individual who shall have the right to vote in matters affecting its membership.

(c) The membership of the Institute shall, by processes determined by the Board, nominate candidates for the three seats on the Board prescribed by section 104(c)(4).

(d) Beginning with the second year of the Institute's existence, an annual conference of the membership shall be held to review the programs of the Institute and to consider future plans.

(e) The term of an organization's or institution's membership in the Institute shall continue until the termination of the Institute, under section 103, unless (1) it theretofore re-

signs, or (2) it fails to pay the established dues for more than six months after written notice of its nonpayment of dues; but a member whose membership is terminated for nonpayment of dues shall be entitled to automatic reinstatement to membership during the period of one year following such termination by paying all unpaid past and current dues.

(f) A member may resign its membership in the Institute by written notice mailed to the Director of the Institute at least thirty days prior to the effective date of its resignation.

TERMINATION OF THE INSTITUTE

SEC. 103. The Institute shall terminate its existence ten years after the date of the enactment of this Act, unless the President, in a written message to the Congress, shall extend its lifetime for an additional five years. In making a determination to extend its lifetime, the President shall evaluate the extent to which the functions of the Institute have been or may be successfully integrated into existing institutions of the executive branch.

FUNCTIONS OF THE INSTITUTE

SEC. 104. The Institute is authorized and directed—

(1) to collect and assess data and information about developments and trends in information science and technology throughout the world, including the efforts of foreign governments to develop and articulate national information policies;

(2) to propose broad national goals for the productive and humane use of information technology, and for the preparation of citizens to benefit from the ability of this technology to organize and provide access to large collections of information;

(3) to conduct and support research into the broad policy issues concerning human interaction with, and acceptance of, information technology in the home, school, and workplace;

(4) to examine and assess potential impacts on regulatory structures of new technology configurations, and to propose regulatory policy options responsive to new or novel applications of information technology and telecommunications;

(5) to investigate policy options aimed at establishing a coordinated institutional framework for the planning, conduct, and support of research and development by the Federal Government in information science and technology;

(6) to develop and assess policy options for improving the dissemination of scientific and technical information (STI), with particular attention to (A) coordination of STI activities among agencies and identification of institutional barriers to improved STI flows; (B) integration of data bases through increased networking

capabilities; and (C) improvements in the dissemination of STI generated within the Federal Government or under grants to or contracts with the Federal Government;

(7) to conduct research into and analyses of current and potential international information policy issues, including economic aspects of transborder data flows, access by foreign governments and corporations to United States generated STI, and the creation of international information systems to address the information and communications needs of less developed countries;

(8) to conduct studies and make recommendations aimed at more efficient use of information technology to improve productivity within the Federal Government;

(9) to develop channels of communications and promote extensive interaction between the Institute and appropriate governmental, educational, industrial, commercial, and other private entities, in order to promote innovation, develop more efficient processes of dissemination and utilization of STI, and provide a public policy forum for informed citizen involvement in information issues; and

(10) to serve, to the extent practicable, as a model for the use of information technology, by exemplifying in its organization and function the employment of this technology to enhance efficiency and to promote personal satisfaction and self-fulfillment.

NATIONAL INFORMATION SCIENCE AND TECHNOLOGY BOARD

SEC. 105. (a) The Institute shall be operated under the general supervision and policy control of a National Information Science and Technology Board, which shall consist of fifteen members to be appointed by the President and of the Director ex officio.

(b) The persons appointed to the Board—

(1) shall be eminent in the fields of information science and technology, social and economic impacts of information technology, the classification and dissemination of information, education, technology assessment, science and technology policy, or public affairs; and

(2) shall be selected solely on the basis of established records of distinguished service.

(c) Of the persons appointed to the Board—

(1) four shall be from the Federal Government, including the Director of the Division of Scientific and Technical Information established in the Office of Sci-

ence and Technology Policy as provided in title II of this Act;

(2) four shall be from private sector businesses providing information products or services, or from labor associations;

(3) four shall be from the educational public sectors, or from scientific and professional associations, including the chairman of the National Commission on Libraries and Information Science;

(4) three shall be appointed by the President from nominees made by the twelve Board members appointed under paragraphs (1), (2), and (3) after such Board members have prescribed procedures for such nomination.

(d) The President shall designate one member of the Board as chairperson and one member as vice chairperson for a term of office not to exceed five years. The vice chairperson shall perform the duties of the chairperson in the latter's absence. In case a vacancy occurs in the chairpersonship or vice chairpersonship, the Board shall elect a member to fill such vacancy.

(e) The term of office of each member of the Board shall be five years, except that (1) any member elected to fill a vacancy occurring prior to the expiration of the term for which his predecessor was appointed shall be elected for the

remainder of such term; and (2) the terms of office of the four members first taking office under each of the first three numbered paragraphs in subsection (c) shall expire, as designated at the time of their appointment, one at the end of three years, one at the end of four years, and two at the end of five years. No member shall be eligible to serve in excess of two consecutive terms of five years each.

(f) The Board shall meet no less often than once every three months at the call of the chairperson, or upon the written request of one-third of the members. A majority of the voting members of the Board shall constitute a quorum.

(g) Members of the Board who are not in the regular full-time employ of the United States may receive compensation when engaged in the business of the Institute at a rate fixed by the chairperson but not exceeding the daily equivalent of the rate provided for level GS–18 of the General Schedule under section 5332 of title 5, United States Code, and shall be allowed travel expenses as authorized by section 5703 of title 5, United States Code.

(h) The initial twelve Board members shall act as quickly as possible to adopt bylaws governing the admission of organizations and institutions to membership in the Institute, as provided in section 102. The Board shall have the power to approve memberships, to establish a fee structure, and to create such classes of membership with such rights,

powers, privileges, and limitations as the Board, in its sole discretion, shall deem to be in the best interest of the Institute.

(i) The Board shall, in addition to any powers and functions otherwise granted to it by this Act—

(1) establish the policies of the Institute, in accordance with applicable policies established by the President and the Congress;

(2) review the budget of the Institute;

(3) review the programs of the Institute;

(4) submit an annual report to the President, for transmission to the Congress, describing past, current, and proposed activities of the Institute, and including a report on significant results of the annual membership meeting;

(5) submit biannually to the President for transmission to the Congress, beginning with the third year of the Institute's existence, a five-year outlook on public policy issues concerning information and the application of information technology in both the public and private sectors; and

(6) approve or disapprove every grant, contract, or other funding arrangement the Institute proposes to make, except that a grant, contract, or other funding arrangement involving a commitment of less than

$200,000 may be made by the Director without specific Board action, if the Board has previously reviewed and approved the program of which that commitment is a part.

(j) The Board is authorized to appoint a staff consisting of not more than four professional staff members and such clerical staff members as may be necessary. The professional staff members may be appointed without regard to the provisions of title 5, United States Code, governing appointments in the competitive service and the provisions of chapter 51 of such title relating to classification, and may be compensated at a rate not to exceed the rate provided for level GS–18 of the General Schedule under section 5332 of such title.

(k) The Board is authorized to establish such special commissions as it may from time to time deem necessary for the purposes of this Act.

(l) Board members under paragraphs (1), (2), and (3) of subsection (c) shall be appointed not later than ninety days after the date of the enactment of this Act. The Board members under paragraph (4) of such subsection shall be appointed not later than one year after the date of the enactment of this Act.

DIRECTOR OF THE INSTITUTE

SEC. 106. (a) The Director of the Institute shall be appointed by the President, by and with the advice and consent

of the Senate. Before any person is appointed as Director, the President shall afford the Board an opportunity to make recommendations with respect to such appointment. The Director shall receive basic pay at the rate provided for level II of the Executive Schedule under section 5313 of title 5, United States Code, and shall serve for a term of five years unless removed by the President.

(b) Except as otherwise specifically provided in this Act the Director shall exercise all of the authority granted to the Institute by this Act.

(c) The Director may make such provisions as he deems appropriate authorizing the performance by any other officer, agency, or employee of the Institute of any of his functions under this Act.

(d) The Director shall formulate the programs and budgets of the Institute, in consultation with the Board and taking due consideration of the concerns of the membership. As a basis for the selection and conduct of the Institute's programs, the Director shall prepare, for the approval of the Board, a short-range plan of activities and a long-range plan of activities. Each plan shall as fully as possible prioritize the full range of information policy and research activities appropriate to the Institute. Such plans shall be prepared within one year after the initial selection of the Director, and each such plan shall be updated annually.

GENERAL AUTHORITY OF THE INSTITUTE

SEC. 107. (a) The Institute shall have the authority, within the limits of available appropriations, as to all things necessary to carry out the provisions of this Act, including but not limited to the authority—

(1) to establish additional offices and other organizational structures within the Institute;

(2) to prescribe such rules and regulations as it deems necessary governing the manner of its operations and its organization and personnel;

(3) to make such expenditures as may be necessary for administering the provisions of this Act;

(4) to enter into grants, contracts, cooperative agreements, or other arrangements with whatever persons, organizations, countries, or other entities are deemed most useful by the Institute to accomplish the purpose of this Act;

(5) to acquire, hold, or sell real and personal property of all kinds necessary to carry out the purpose of this Act;

(6) to receive and use funds and property donated by others, if such funds and property may be used in furtherance of the purpose of this Act;

(7) to accept and utilize the services of voluntary and uncompensated personnel, and provide transporta-

tion and subsistence as authorized by section 5703 of title 5, United States Code, for persons serving without compensation;

(8) to arrange with and reimburse other Federal agencies for any activity which the Institute is authorized to conduct;

(9) to receive funds from other Federal agencies for any activity which the Institute or any such other agency is authorized to conduct; and

(10) to appoint and fix the compensation of personnel necessary to carry out the provisions of this Act.

(b) Except as provided otherwise in this Act, appointments under subsection (a)(10) shall be made in accordance with the provisions of chapter 51 and subchapter III of chapter 53 of title 5, United States Code; but the Director may, in accordance with such policies as the Board shall prescribe, employ technical and professional personnel and fix their compensation, without regard to such provisions, as he deems necessary to carry out the purpose of this Act.

TRANSFER OF FUNCTIONS

SEC. 108. (a) The President may transfer to and vest in the Institute, under and in accordance with schedules, procedures, and standards prescribed by the Director of the Office of Management and Budget in regulations—

(1) any or all information or information science and technology-related research programs or policy studies and analyses being conducted or administered within the Federal Government by agencies other than the Institute;

(2) all functions, powers, and duties of any officer or employee of the United States which relate primarily to programs or activities transferred under paragraph (1); and

(3) so much of the positions, personnel, assets, liabilities, contracts, property, records, and unexpended balances of appropriations, allocations, and other funds employed, held, used, arising from or available for the programs, activities, functions, powers, and duties transferred under paragraphs (1) and (2) as may be determined under such regulations to be appropriate. Personnel engaged in the performance of functions, powers, and duties transferred under this subsection shall be transferred in accordance with applicable laws and regulations relating to transfer of functions.

(b) With respect to any function, power, or duty transferred under subsection (a) and exercised by the Institute after the date on which this section takes effect, reference in any Federal law to the agency or officer from which the

transfer is made shall be deemed to be a reference to the Institute or the Board.

AUTHORIZATION OF APPROPRIATIONS

SEC. 109. (a) There are hereby authorized to be appropriated to the Institute—

(1) $20,000,000 for the fiscal year 1982;

(2) $25,000,000 for the fiscal year 1983; and

(3) $30,000,000 for the fiscal year 1984.

(b) Funds appropriated pursuant to subsection (a) shall be in addition to any funds provided from fees paid by the members of the Institute and by additional fees for particular research projects.

TITLE II—DIVISION OF SCIENTIFIC AND TECHNICAL INFORMATION

SEC. 201. Title II of the National Science and Technology Policy, Organization, and Priorities Act of 1976 is amended by adding at the end thereof the following new section:

"DIVISION OF SCIENTIFIC AND TECHNICAL INFORMATION

"SEC. 210. (a) The Director shall establish, within the office, the Division of Scientific and Technical Information.

"(b) The primary function of the Division of Scientific and Technical Information shall be to assist the Director in formulating policy and providing advice within the executive branch on scientific and technical information and the tech-

nologies involved in its collection, processing, and dissemination. In so doing the Division shall—

"(1) provide close liaison between the Executive Office of the President and the Institute for Information Policy and Research;

"(2) provide assistance to the Office of Management and Budget with an annual review and analysis of funding proposed for research and development in information science and technology and the dissemination of scientific and technical information in budgets of all Federal agencies, and provide assistance to the Office of Management and Budget and the agencies throughout the budget development process;

"(3) establish a suitable mechanism to coordinate the activities of the Institute for Information Policy and Research with those of executive branch agencies having significant responsibilities for research, development, and application of information science and technology, including, but not limited to the Department of Defense, the National Science Foundation, the National Bureau of Standards, the National Aeronautics and Space Administration, the National Telecommunications and Information Administration, the National Technical Information Service, and the Department of

"(4) investigate the feasibility and desirability of a coordinated Federal information locator system for scientific and technical information generated within the Federal Government or under grant to or contract with the Federal Government;

"(5) make recommendations to the President for improving dissemination of scientific and technical information both within the United States and internationally, and for better coordinating scientific and technical information activities among agencies of the executive branch; and

"(6) make recommendations to the President concerning appropriate institutional mechanisms for fostering research and development activities in information science and technology.".

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Institute for Information Science and Technology
The George Washington University
Tompkins Hall of Engineering
725 Twenty-third Street, N.W.
Washington, D.C. 20052

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INSTITUTE FOR INFORMATION SCIENCE AND TECHNOLOGY

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January 1980

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Contents

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EXECUTIVE SUMMARY

The George Washington University is creating an Institute for Information Science and Technology. Established at the suggestion of senior government officials, the Institute is an interdisciplinary resource center which conducts basic and applied research in information science for government and industry.

The central focus of the Institute is on information in government—that is, government as both a user and policy maker in information science and technology. Issues such as the relationship between information systems and policy formulation, decision making and problem solving will be examined. The Institute brings people, ideas, and resources together, and acts as a catalyst for research in furthering the state-of-the-art in information science and technology. The Institute also conducts applied research efforts with more near-term outputs when such research bears on the central theme of the Institute research plan.

The research plan outlined within describes study efforts in research activities such as the fundamental understanding of the decision-making process in government, information display systems, and the conversion from paper to electronic communications for offices of the future. Detailed research program plans are contained in Volume II, a supplement to this document, available in the near future.

The Institute operates as a multidisciplinary research organization, with a foundation built in the field of science and engineering. It brings together the strength of disciplines from both the physical sciences and the social sciences, including law, education, government, psychology, political science, engineering, mathematics, geography, and others, in order to understand human-machine interactions and to understand appropriate designs for effective information systems for the future.

This document outlines the organization and development plan for the formation and initial five-year period of operations of the Institute, and includes organization, procedures, staff positions, capabilities, and budget. Primary sources of funding are foundation grants and government and industrial research grants and contracts. The Institute operates with a core staff, and relies on faculty and research contributors from George Washington University, as well as a broad range of other sources from government, industry and academia. Visiting scholars and fellows from government and industry fill important research positions while pursuing advanced studies.

The Institute is organized to conduct interdisciplinary educational and training programs by integrating mid-level scientists and managers into Institute research programs in order to provide them with greater insight into the latest research findings in the field of information science and technology. There is a deliberate mix of permanent and adjunct staff: government, industry, and university staff; practitioners and researchers; senior researchers and students—a cross-fertilization of the spectrum of skills and roles that can be brought to bear in the field of information science.

The Institute for Information Science and Technology's output products include: research publications, grant and contract reports, and scholarly papers; systems designs and developmental demonstrations; continuing education programs, seminars, and conferences; and trained staff and alumni.

1. INTRODUCTION

BACKGROUND

To an increasing degree, the preparation of legislation and the exercise of government are dependent on the quality of information and information handling which can be brought to bear. This dependency has created relationships between two groups who are relatively unfamiliar with the theory and practice of each other's fields: legislators and government executives on the one hand, and information scientists and technologists on the other. This is compounded by the fact that the field of information science is itself interdisciplinary. The development of information systems depends not only on technical scientists and engineers, but also on social scientists, lawyers, political scientists, educators, sociologists, psychologists, and many others. It is a truism that the practitioners of many scientific disciplines seldom interact with those in other fields; the language and literature of each discipline is unique and distinct. Distrust, jealousy, and substantial resistance to input from other fields are not uncommon. In the field of information science, however, this reluctance to cross-fertilization must be overcome; the design and operation of information systems must be viewed as an interdisciplinary venture.

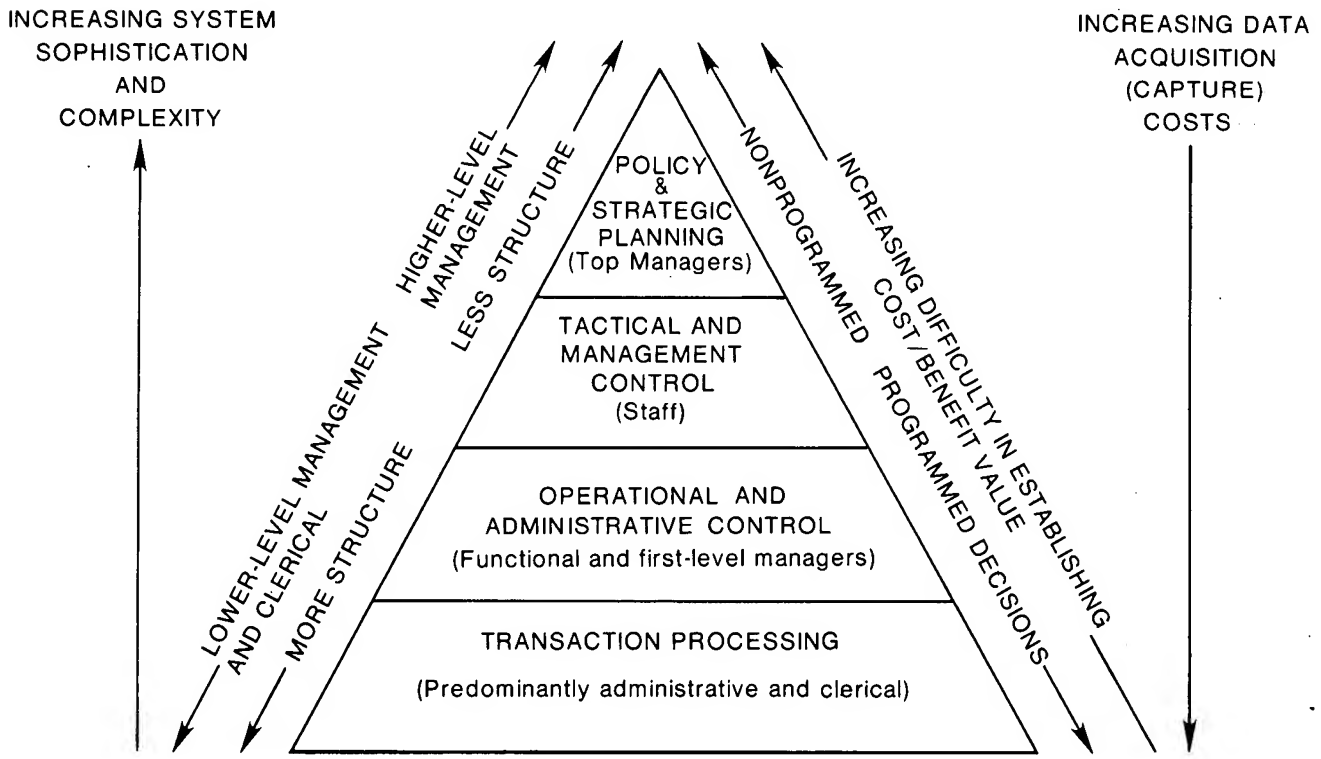
A model for representing information systems is presented below.* Here the information system is viewed as a pyramid, with a large number of routine transactions and structured clerical activities forming the base, and a relatively smaller number of increasingly complex and sophisticated functions at the peak.

This representation of information handling systems illustrates their ubiquity in today's society. The value of these systems, to their users and to society in general, varies widely. They are used at one end of the spectrum, for example, by the top levels of management in decision-making systems such as MIS; they are used by middle management in such systems as PERT; and clerical level staff utilize a myriad of word processing, text processing, and facsimile systems for routine information handling needs. The proliferation of a multitude of equipment and systems creates an ever-increasing need to address the long-term substantial issues: how can these existing systems be made to evolve into future systems which serve both government and industry most usefully?

The Institute for Information Science and Technology proposes to address this need.

*Adopted from Gordon B. Davis, *Management Information Systems*, McGraw Hill Book Co., New York, 1974

AN INFORMATION SYSTEM PYRAMID



NEED FOR THE INSTITUTE

Today slightly more than half of the working population of our nation is engaged in information handling activities, and this portion of our economy is still growing. While energy resources are becoming increasingly scarce and expensive, information resources are proliferating at a great rate and decreasing cost. Information, and the ability to rapidly analyze and display it, represent substantial power. It is essential to have a long-range, objective, institutional view of the design, application, and consequences of the implementation of advanced information systems.

The ideas and expressions of need inherent in the research programs in this document were for the most part gathered from prospective users of the research and services which the Institute will offer. Some programs are targeted to current pressing needs in certain agencies; others have a longer focus—into the next millenium in one instance. Following the nature of the needs, there is missing connective tissue between very specific data processing and information science projects and the very general needs of government for improvement in these areas. This lack of definition underscores the need for an institution to explore the gaps and to assist in the development of a body of philosophical and policy rationale for the deployment of information systems technology in ways which are consistent with the ends of government and society.

An institution which is technology-based and multidisciplinary can serve as a significant resource center to provide long-term research on information needs, problems, and policy for government and industry. It is a fundamental requirement that the center must be in close working proximity to the center of Federal government operations. The products of such an institution will be most valuable if a deliberate mix of current practitioners and scholarly experts jointly address the pertinent issues.

The field of information science is so new that it is still not well-defined as to breadth and depth, content and coverage. Although information systems can exist without computer technology, the Institute for Information Science and Technology is primarily interested in the future of systems which are predominantly computer-based. The relevant questions then become how and to what extent computers will be used, and how and to what extent humans and machines will interact. As the interaction becomes more intense, more intimate and often more hurried, human limits of perception are met. Increasingly, the broad channel capacity of our eyes, stimulated by pictures from computer graphics and display systems, is relied upon to overcome these limits. As organizations, private and public, industrial, academic and governmental, become larger and deal with increasingly complex technology and decision making, the need for improved information systems becomes critical.

Such an institution can also be of great service to government in helping to enrich communications between information providers in executive-branch agencies, and consumers in the Congress and the White House; between successive Administrations; and between government and information industry technologists.

Although the Institute focuses primarily on Federal government needs, the research outputs have direct application to industrial needs. And to the extent that government becomes more expert at decision making, policy formulation and problem solving, all of society benefits.

FEDERAL GOVERNMENT NEEDS

The Federal government's need for information systems is great and growing rapidly. The government is in the information business. The Federal government is both the largest generator of information and the largest consumer of information, and it has the largest data banks. In order to take maximum advantage of this information, it must advance technologically and socially in the use of electronic information systems. The attendant issues of this advancement—not the least of which is safeguarding our democratic institutions and ideals—are monumental.

Within the past thirty years, the size, scope and impact of government have increased over tenfold. Concurrently, technology, particularly in the area of information systems, has created a whole new world of capability and promise for those who must make decisions in the last decades of the 20th century and into the beginning of the 21st century. The need to link the world of government and the world of technology has grown more critical as this nation's economy and its natural resources have become increasingly scarce and limited. Decision makers of today are forced to choose among the competing interests and needs of society, to determine that the monies allocated are not wasted or abused, and to ensure that the specific intent of legislated programs is achieved effectively. Difficult political choices are never fully rational. While information systems cannot automate a manifold process of limited rationality such as government decision making, they can improve the quality, quantity, and sharing of information and communication resources which support the process.

Although the Federal government has recognized for more than thirty years the need for quality information in the areas of defense and security, it has only in this decade begun to focus on its capabilities in the field of domestic information with the same rigor and intensity. It has been only three years since Congress commissioned the creation of an information system to serve its newly formed Congressional Budget Office, its members, and its committees. Each domestic agency within the Executive branch is at some stage in establishing data systems that will allow for the collection, storage, display, and utilization of the base line information needed to make yearly budget, legislative, and program implementation decisions. Even with these early attempts to couple information needs with information technology, many government decision makers still rely on anecdotal information regarding problems, causes of those problems, possible solutions to those problems, and probable impact of government funding. There is no single facilitating mechanism for the transfer of industrial and defense information technology to civil government applications. As an example, in too many government agencies, the most sophisticated technology used to reproduce and transmit information is the photocopying machine and the courier's automobile.

The Federal government today is burdened with antiquated, time-consuming operating methods, and faces at the same time the need to have access to information which optimizes decision making at minimal costs. Information systems cannot guarantee the efficacy of government, but they can provide

basic tools for modernization and the promotion of more efficient, responsive and effective government decision making.

Technological discoveries will continue at a rapid pace over the next thirty years. Given the pressures and countervailing forces which require better decision making in the future, government cannot afford to remain in the early technological age. The thoughtful application of information technology to the following government needs is required now:

First, the collection and availability in useful form of basic information regarding the conditions of society, and an estimation of the relative importance of these conditions to the nation's health and well-being;

Second, the availability of information at critical points in the government decision-making processes—budget formulation by the Administration and its negotiation with the Congress, legislative development by the Congress and the Administration, and program implementation by the Executive branch;

Third, the collection and availability in useful form of technical information, including information about substances that affect health, safety, food and the environment, to improve government effectiveness in determining when and how—or whether—to regulate in the public interest;

Fourth, the ability to electronically transmit and retrieve information quickly among and within agencies, in order to minimize the burdensome paperwork.

At the highest levels of policy and decision making in the government, the shortcomings of current information systems are those of communication and integration, not computational power. There is great need to develop an optimum method of integrating the variety of piecemeal information systems now available: data processing, text editing, electronic mail, micrographics, computer graphics, financial management systems, and other sophisticated decision support systems. It is generally acknowledged that a long-term evolutionary approach is necessary to define integrated information systems for decision making and policy formulation.

A current example is the Domestic Information Display System project,* an important first step to the formation of a distributed geography-based information display system. Although computer-generated cartography is being used in a few Federal and state agencies, and in some local governments, a national system which serves all branches of the Federal government does not exist.

It will take years of basic and applied research to design, develop, test, and implement integrated information systems for Federal decision makers. Early research programs will permit early operational systems, and produce near-term benefits in the process. The need to address this task has been a guiding concept in the formation and development of the Institute for Information Science and Technology.

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*An inter-agency Federal project

NATIONAL NEEDS

In addition to its role as a consumer-user of information systems, the Federal government can be a powerful agent in fostering the growth of the information economy. Forward-looking projects such as the information system planned for the Executive Office of the President can be role models for emulation by other Federal agencies, state and local government, and private sector organizations. Interactions between defense and civil agencies can effect delivery of information technology developed for national defense to civil and domestic applications. This in turn can create new and broader markets for the results of defense research and development dollars.

None of the above possibilities are automatic or necessarily efficient. The mission-oriented agencies which might be productively involved in these activities do not have such cross-fertilization or technology transfer in their charters, even though the economics—especially potential savings—are compelling. Organizations which are external to the government play a vital role in addressing this need.

The government's role as policy maker is most crucial to the success of the indigenous information economy of the United States, and to its successful competition in the world marketplace. Some of the benefits of Federal democracy turn out occasionally to be disadvantages when competing with, say, monolithically governed emerging countries bent on establishing their own indigenous industries and world marketplaces for information technology. More attention needs to be paid to increasing our government's awareness of the needs and policy opportunities afforded by technological advances. The government occasionally requires assistance in avoiding the maintenance of policy or regulatory barriers which should fall to advances in technology.

The Institute can play a focal role in meeting these national needs, by being a nexus for people and ideas, in Washington. A NASA official recently put it this way: "Getting one of the key decision makers off the Hill or out of the White House to see a computer demonstration is like sending a rocket to the moon: the first mile is the hardest."

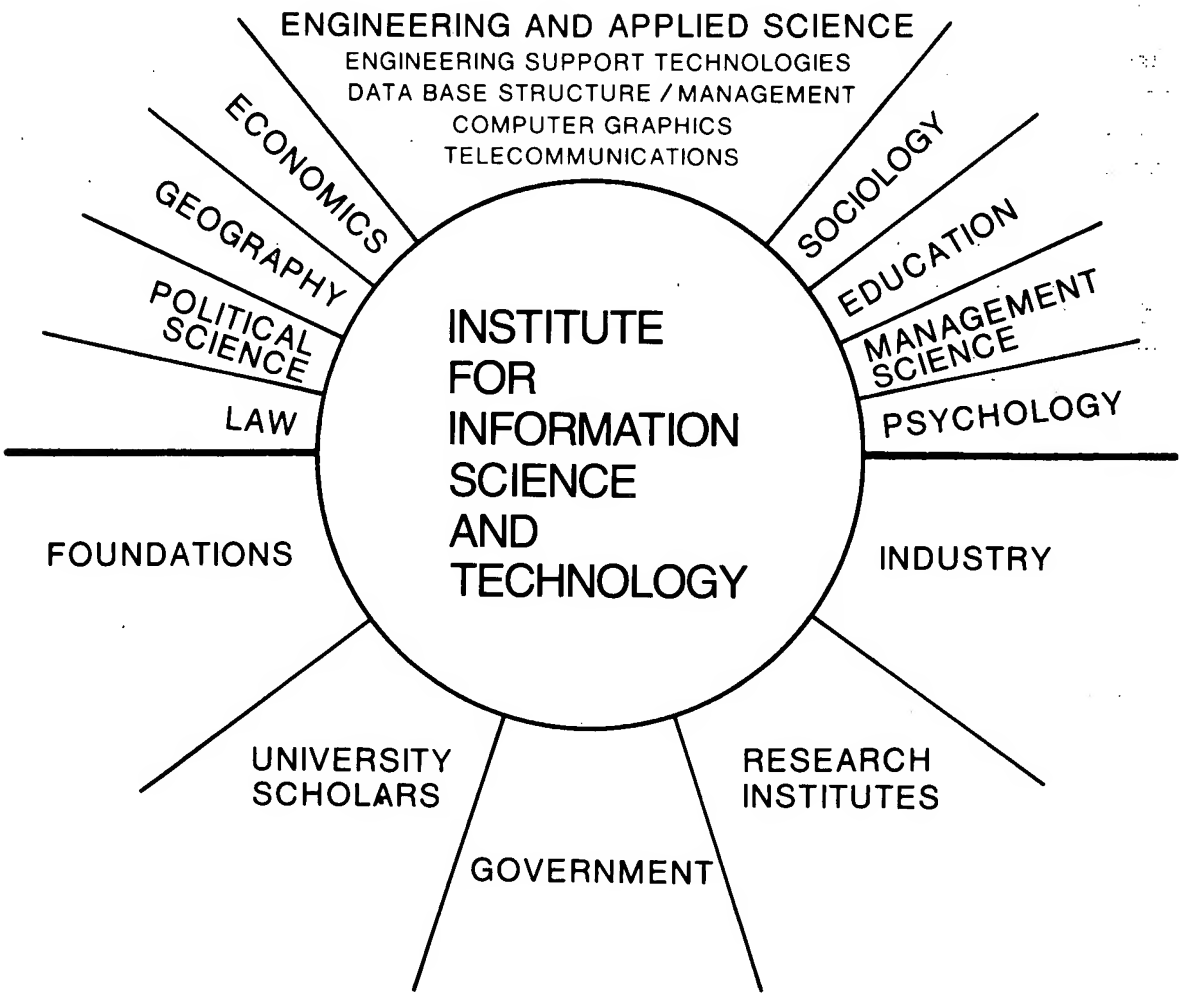
INSTITUTE PURPOSE

The Institute for Information Science and Technology is a multidisciplinary resource center whose purpose is to conduct basic and applied research in information science and technology for government and industry. The Institute is a unique research organization as distinguished by its central focus on government information issues; that is, the relationship between information technology and policy formulation, decision making, and problem solving in the government represents the core of its research thrust. Secondly, the Institute is located in Washington, D.C., in close proximity to the nucleus of Federal government operations. Its purpose is to bridge the gap between technology and policy formulation by bringing together technologists and academicians into intensive and continuous contact with government executives and legislators. In the future when electronic acculturation has taken place and when information networking is a reality, there might not be as great a need for the Institute to be physically located in Washington; until that time, the need for physical proximity to the center of Federal government operations is clear.

The Institute is a systems research and development organization whose purpose is to conduct research, design, and development efforts resulting in computer-based information systems including software and hardware experimental designs. As a conceptualizer, an architect of future system needs, it will not be involved, as a matter of policy, in the actual production of hardware.

The Institute is a resource center whose purpose will be to build incrementally, over a period of years, a means of maintaining a contemporary capability in information science and technology. The use of a multidisciplinary cadre of experts will improve the general acceptance and usefulness of information systems, in part by increasing the efficiency and efficacy of communications among policy maker, analyst, and computer.

The Institute is a multidisciplinary scientific organization whose purpose is to bring together people, ideas, resources, and act as a catalyst for results. The problems and concerns of government, industry, and academia are addressed with inputs from all sectors of society, and virtually all academic disciplines. The purpose of the Institute's research programs is to support the application of information technologies and the design and development of information systems of the future for government and industrial use. The Institute is a contemporary laboratory where practitioners and researchers are brought together to focus jointly on the problems of user needs. There is a deliberate mix of permanent and adjunct staff: government, industry, and university staff; practitioners and researchers; senior researchers and students—a cross-fertilization of a broad spectrum of skills and roles that can be brought to bear on the issue of information science.



INSTITUTE PRODUCTS

The Institute provides its sponsoring agencies, and society in general, three basic products: reports and publications on research activities and policy analysis; design and developmental efforts on information system software and prototypes; and the training and education of Institute staff, researchers, and clients.

The principal products of the Institute for Information Science and Technology are research reports describing planned research activities, research in progress, and completed research. Reports will be in the form of scholarly papers, research memoranda, reports in response to contracts and grants from sponsoring agencies, and presentations to professional groups and societies.

The Institute will develop for its own use integrated information systems to support operations and research programs. Thus the Institute itself is to be a living laboratory for experiments in improving the efficacy of research organizations with information technology support. Specialized programs will require special systems—interactive high-resolution color graphic displays, for example. Prototypical information systems software, data bases and equipment configurations may be developed to meet specific project requirements.

Finally, the Institute will conduct education and training programs for its permanent staff, interns, information systems users, visiting scholars and graduate students, and clients. Participants in Institute research will be engaged in some form of training or educational program, not only within the Institute's confines, but also at the George Washington University and other universities in the Washington metropolitan area.

In a very real sense the Institute itself will be a product, an outcome. The incremental development of this unique national capability in the field of information science will result in a valuable resource.

The Institute will seek to utilize the foremost available expertise in the development of these products. It will, for example, develop and publish a "capabilities register," compiling a select international list of researchers and skills available in the field of information science and technology. The Institute's Resource Center, described later, will be responsible for the initial publication and subsequent revisions of this register. The Resource Center will also be responsible for the continual survey of the research literature in the field required to keep staff and clients abreast of current research activities and technological developments. It will also develop and publish a selected bibliography of current needs in information science and technology.

2. INITIAL RESEARCH PLAN

The Institute for Information Science and Technology is a resource facility for the conduct of basic and applied research in the field of information science and technology. The Institute's research plan is organized around major research programs. Each research program is weighed and analyzed within the context of the Institute's overall mission, available resources, and the relative value of its output to the current and potential knowledge base and needs. Many of the Institute's research programs are designed to answer specific research questions and relate to specific sponsoring organization's needs. Other programs are long-term basic research with no finite termination which will produce intermediate results, publications, and potential applications.

Each research program is divided into a series of specific objectives, subobjectives, and research tasks and activities. Many tasks and activities will relate to more than one research program; that is, the outcome of one research task may be necessary input to or linkage with research tasks integral to other research programs. The details of these programs and their interrelationships are contained in a supplemental document, "Research Program Details."

The Institute conducts research directed from a broad interdisciplinary viewpoint in information science in support of decision and policy making. Although many of these study activities are responses to government and industry requests for proposals and grant competitions, some of them will be internally identified, or the result of unsolicited proposals.

The Institute for Information Science and Technology has established five research programs for its initial study efforts:

I. INFORMATION SYSTEMS SUPPORTING DECISION MAKING, POLICY FORMULATION, AND PROBLEM SOLVING FOR GOVERNMENT

II. INFORMATION NETWORKING AND OFFICE INTEGRATED INFORMATION SYSTEMS

III. FEDERAL GOVERNMENT INFORMATION SYSTEMS—CIRCA 2010

IV. INFORMATION DISPLAY SYSTEMS RESEARCH AND DEVELOPMENT

V. RESEARCH IN HUMAN-MACHINE INTERACTIONS

These five research programs represent only a beginning in the spectrum of research needs in the field. The matrix of initial research program domains summarizes the impact of these initial research activities on the entire field of information science and technology. The list is not meant to be as definitive as it is to be provocative. It will evolve as the Institute's research plan becomes more defined and is further described in the forthcoming supplemental document of research program details.

In addition to its research programs, the Institute for Information Science and Technology has established a Resource Center to serve as a clearinghouse for information and research services to the field.

An introductory description of these initial research programs is included below. Some of these descriptions are very specific; some are general, and will be defined in specific proposals to be developed during the first year of operation of the Institute.

INITIAL RESEARCH PROGRAM DOMAINS

Information Science and Technology Descriptors	Research Program I Decision Making	Research Program II Information Networking	Research Program III Federal Information Systems	Research Program IV Information Display	Research Program V Human-Machine Interactions
• Fundamentals (examples):					
Access	●	●	●		●
Artificial intelligence			●	●	●
Computer science	●	●	●	●	●
Decision theory	●		●		●
Economics	●		●	●	
Human-machine interaction	●	●	●	●	●
Information management	●	●	●		
Language translation & linguistics		●	●	●	●
Mathematical foundations		●			●
Policy and regulation	●	●	●		
System architecture & topology	●	●	●		
System management and control		●			●
Telecommunications	●	●	●		
Applications (examples):					
Computer conferencing	●	●	●	●	●
Computer graphics	●	●	●	●	●
Computer-assisted instruction		●		●	●
Data processing		●			●
Electronic funds transfer					●
Electronic mail	●	●	●	●	●
Exotic forms: music, genetics, chemical formulae			●	●	●
Information storage and retrieval	●	●	●		
Library sciences		●			●
Management information systems	●	●	●		●
Mass media (radio, TV, motion pictures)			●	●	●
Micrographics	●			●	●
Office automation		●	●		●
Personal media (telephone, videotape, postal service, personal computers)	●	●	●	●	●
Publishing (books & periodicals)		●		●	

RESEARCH PROGRAM I:

INFORMATION SYSTEMS SUPPORTING DECISION MAKING, POLICY FORMULATION AND PROBLEM SOLVING FOR GOVERNMENT

The process by which the Federal government makes decisions and formulates policy is unique to its organization. Although the process of decision making in industrial organizations has been widely studied, the necessarily unique processes of the Federal government have been subject to little documentation or analysis. Information systems should be extremely valuable support tools to decision and policy makers at all levels of government. The purpose of the first research program is to develop a detailed understanding of the decision-making process in the Federal government, and the role of information systems in supporting that process.

As many of the separate government departments and agencies begin to adopt information systems or components of such systems, a myriad of diverse and unrelated systems evolve. To forestall this piecemeal approach, a comprehensive and architecturally sound capability must be developed incrementally over the next years.

Impact of Information Systems on Decision Making and Policy Formulation

The Institute's multidisciplinary expertise will be brought to bear on a study of the impact of information systems on decision making and policy formulation. This study effort will include the identification and analysis of techniques and issues involved in policy formulation, decision making, problem solving, program formulation, organizational decisions, and other management activities. Geographic issues involved in these analyses will also be considered.

The effect of policy considerations and political trade-offs on the decision-making process is an important area for research analysis. Even where complete and reliable data and advanced information technologies are available to decision makers, policy factors will sometimes outweigh rational decision making factors. It will be valuable to address the impact of information systems under both optimal utilization conditions, and in those situations where less than optimal utilization is mandated by policy factors.

Analysis of Government Decision-Making Process

Documentation and analysis of the process of civilian government agency decision making, intra- and inter-departmental, are the necessary fundamental steps towards a systematic, structured understanding of decision making in these organizations. This understanding will be the necessary basis for planning the modifications in the process which will be required as conversions to electronic systems occur. Since there is substantial diversity in both decision-making methods and decision makers, the Institute's goal is to facilitate the transfer of already-developed capabilities from defense and aerospace applications, and as necessary, develop tools which are tolerant of this diversity. Specifically, analysts must identify:

- Information used in decision making; type, quantity, currency, source, reliability, accuracy;
- Current method of display and presentation, and utility in decision making;
- Originators and users of the data;
- Decision points in the process;
- Additional data that may be useful in the process;
- Time scales upon which data needs are based.

To identify these factors, specific research activities will be formulated to construct the route of decision making and policy formulation in a representative sample of government agencies. Generalizable conclusions will be drawn from this sample. This is an interdisciplinary task which requires inputs from a number of disciplines, including political science, management science, psychology, sociology, government, law, and other areas of expertise.

The results of this research will have immediate application in the Domestic Information Display System (DIDS) program. The DIDS program is the initial step to what could be a national geography-based information display system. The program is currently limited to a small staff in the Department of Commerce and utilizes the available technology; the initial efforts of this demonstration have been very well received. The Institute for Information Science and Technology can be a significant research contributor to the DIDS program. Many applied research issues remain to be studied to assist in the evolutionary development of the Domestic Information Display System.

Data Base Management System

The essential element in every information system is the data base management system (DBMS). An adequate DBMS is a requirement for an available, accessible, maintainable information system. However, DBMSs used with certain specialized systems such as geo-based information systems have special requirements. These areas of special need will be addressed by Institute staff as part of this research.

A fundamental issue is the design of storage structures which optimize performance for the manipulation of issue-relevant data. For instance, there is a fundamental conflict between storing data for use in time series calculations and plots, and storing data for use in choropleth maps. In the first instance a single variable is to be accessed as a function of time; in the second case, as a function of geographical location. This is the type of need which will be explored by this research program.

Standards Research and Development

The interrelationship between the development of uniformly recognized and accepted standards, and the development of a comprehensive information system policy, is poorly understood and not a subject of current research. Widespread information interchange and access require many levels and types of standards. In many areas, standards are now in place or under development; in other areas, the need for standards has been identified but development of these standards has not yet begun; finally, there are areas in which the need for standards has not yet been recognized.

The Institute proposes a two-pronged approach to meet these needs. First, all areas which require standardization will be enumerated. Researchers will then match existing or developing standards against areas of need, and against existing and proposed information policies. Where appropriate, the Institute will press the National Bureau of Standards, the Electronic Industries Association, the Computer Business and Electronics Manufacturers Association, and the American National Standards Institute to develop appropriate standards.

Second, the Institute will itself develop standards proposals in areas which are particularly germane and critical to the growth and progress of Federal information systems. Two areas of need in which Institute staff are experienced are standards for defining geocoded data and its associated geographics, and standards for device-independent graphics subroutine packages. Other important areas for standard development include: word processing command languages, low-speed communication protocols for electronic mail, and statistical extensions to data base management systems.

Information Requirements and Structure

An interdisciplinary analysis will be made of government agencies' information needs, both current and future. The following types of information requirements will be reviewed initially: agency operations and management, regulatory, governmental, financial, project management, legal-institutional, public health and welfare, foreign and domestic policy, and special purpose.

After projecting requirements for future information needs, an analysis of the impact of these needs will be made on information system capabilities for government agencies.

In the area of information structure, recent work in the Executive Office of the President has suggested that data for decision making is arranged in three levels: first, statistical or technical—the most common kinds of input data; second, policy data—data which has been processed to provide options for decisions; and third, political data—the product of final policy analysis.

Within this context, the need for an improved information structure is clear. How can information be rearranged so it is more accessible and useful to decision makers? How can the quality of data be depicted? How can the decision maker query originators concerning the pedigree and interpretation of information? Improved structures should provide for broader access, improved timeliness, prevention of inadvertent filtering by subordinates, exposure of full depth of available information for decision makers, and the arrangement of data by issues. These needs will form the basis for development of specific research tasks.

RESEARCH PROGRAM II:

INFORMATION NETWORKING AND OFFICE INTEGRATED INFORMATION SYSTEMS

The substantial developments at the less sophisticated routine clerical end of the information spectrum have not been mirrored at the more complex level, where integration of information into the total business environment is required. Accomplished word processing systems are rapidly being adopted to many new commercial and government uses. Free-standing systems for text processing, electronic mail, report writing, and information retrieval are available from many sources. Operational electronic-based management and project control systems are also widely available. The integration of such systems throughout the information handling operation, however, has not proceeded at the same pace. The design approach must facilitate the integration of these systems through information networking and must result in increased automated information processing functions throughout the office. The integration of automated processes through information networking is termed "auto-processing" by the Institute, and should be clearly distinguished from "office automation."

It is potentially possible to use a central computer tied to peripheral terminals to minimize the paper required to handle files, internal communications, access to reports and documentation, and management control of operations. The technology is available now and is only a short logical extension of existing word processing equipment. The incorporation of an efficient interface between the worldwide telecommunications network and these interoffice systems will create a new realm of possibilities, challenges, and problems. By tying a computer "network" together with "intelligent" terminals globally, an entirely new set of possibilities for management information systems emerges. These systems then offer opportunities for external communication; interorganizational transactions; real-time control of budget, inventory, and operations; and elimination of delays in executing policy and in gathering timely data needed for effective management and decisions.

The system under discussion is not merely a patchwork of word processing, commercial data base management, and electronic mail systems. Rather, it is the integration of this existing and projected technology into a comprehensive unit which causes the whole system to be substantially more powerful than the sum of its constituent parts. The implications are at the same time exciting and potentially disruptive. For example, it is possible to replace much travel and its attendant drain on energy resources with computer communications. But conference communications such as interactive shared visual displays may do more than simply eliminate substantial amounts of long-distance business travel: because the majority of workers today are involved in service industries which basically manipulate and manage data, it is in principle possible to have people work in their homes using terminals interconnected through a data network. Although the end result may not be so untraditional, integrated information systems would certainly challenge the basis of centralized metropolitan work centers. Because we are now at the threshold of implementing such systems without understanding the possibilities and implications they suggest, the Institute proposes certain fundamental research.

Basic research must first project the many possibilities inherent in conversion of offices to integrated electronic and telecommunication systems, and then analyze the impact and opportunities created by various systems. Finally, the next generation of systems integration can be designed and developed in response to the chosen alternatives, using the computer as the central communicator common to all these development efforts.

Distributed Data Communications and Processing Networks

Communications networks are the basis for integrated office auto-processing, consisting of many local work stations and responsive to heavy communications needs. The Institute proposes research in data communications issues and the analysis and design of reliable, survivable networks.

Extensive research is needed in several aspects of data communications. Although similar topics are currently being studied by universities and industry, the emphasis on scale and integration of office auto-processing by the Institute creates original problems.

- Investigation of formal techniques for design and evaluation of very large computer networks and of protocol alternatives. These investigations will be supported by computer simulation and followed by implementations appropriately scaled to microprocessors and local area networks. The object of this research is to develop algorithms and techniques to design teleprocessing networks which employ the most advanced protocols and architectures.

- Design of networks providing optimum protection and integrity of data transmitted over them. Issues such as security and privacy will be addressed, along with needs for public cryptographic protection. Interactions between network architectures and protocols and data base structures and management will be considered in creating the optimum network design.

- Analysis of potential performance of telecommunication networks, based upon performance parameters which include transmission reliability, cost/benefit analysis, network reconfigurability, transmission media (wire, optical fiber or satellite) and network modularity.

- Research on error control in teleprocessing networks, taking into consideration fault tolerance techniques which lead to robust network designs and provide for reliability and accuracy. This topic could include redundant communications, data bases, and attendant problems.

- Development of techniques to employ data compression in the design of more efficient and less costly teleprocessing networks. This research will attempt to develop advanced techniques for data compression and representation in the transmitting media and stations, as well as within the digital switching facility.

- Investigation of novel uses of telecommunication, such as shared interactive visual displays, office-in-home concepts, electronic "lockers" and mailboxes, and resource sharing.

Interfacing the Auto-Processing Office with the External Environment

One of the principal development issues of an integrated information system will be its interface with people, offices which still use conventional office practices, and other public and private institutions such as the courts, banks, libraries, and schools and colleges. Analysis of this issue will require an examination of how existing interfaces between institutions can be adapted to fit the situation when both parties rely primarily on auto-processing, and the situation where one party only retains conventional office techniques. Telecommunications will be considered since interfacing offices are not necessarily adjacent. Impediments to a smooth transition from the conventional to the auto-processing office may also arise from different organizational and operating procedures, and these will be studied.

A number of fundamental research issues will be addressed. Some of these are deliberately general and will be detailed later.

- Management science issues, including fundamental management technique;
- Human systems issues, behavioral sciences, and organizational interrelationships;
- Structures and processes of domestic and international agencies and their interface to the office;
- Human resource issues, personnel management, and job classification;
- Problems arising from the geographic dispersal of offices, markets, and services.

Privacy and Security Policy Issues

The application of integrated information systems for decision support raises several issues that need to be explored: rights of access versus privacy of information; requirements to provide information versus the need to protect sources; public versus private sector contributions and use; coordination of agency roles in providing integrated data bases; and quality control.

Institute research will assess the impact of microprocessors on privacy and the use of microprocessors as integral parts of computer security systems. Another research area of use to decision makers will be risk-benefit analysis; this is always the first step in security planning. Analyses of the impact of privacy regulations and law in electronic mail, point of sale, and electronic fund transfer systems will be made. Institute research will provide technology assessments of information systems, and their uses and will be oriented to identifying the potential benefits and vulnerabilities posed by introducing such systems on a significant scale.

Effective Use of Low-cost Systems

A basic cost consideration in all systems is the high relative cost of human time as opposed to machine time. For all computers, program development requires significant input of human time. But, in determining the choice of a large versus a small computer, it is useful to view the writing of programs as a text processing function. Small computers have been highly successful as word processors serving the text editing function. Particularly if software is written in small, thoroughly tested modules, a small, slow computer is adequate to the task.

It is not feasible, however, to do large-scale computation on a small computer, and therefore completed applications must be transferred for efficient execution. Notwithstanding recent progress in identifying this issue and the availability of some systems (such as the Bell Laboratories Unix System) which address it, it is apparent that an entirely new array of issues and problems arises when the scale is large, the community of users is heterogeneous, and the purposes served transcend text editing.

The economics of small computers are clear, since the cost of human time is so much more important than machine time in program development; but there are more subtle factors adding to the value of personal computers. For example, it is difficult for programmers to overcome a "taxi meter" mentality when using a time-shared computer. It is natural for users to respond to unit time charges by economizing on time devoted to design considerations. Completed programs, therefore, tend to be less clean and more costly to maintain. Also, because operating systems, command languages, file conventions, etc., are completely controlled by the user of both large and small computers, consistency and custom tailoring are feasible in both cases, negating the possible advantage of the larger computer.

The Institute's research task is the development of a unified set of programming tools which will permit a variety of users to switch applications among small dedicated (or personal) microcomputers and large diverse installations as necessary.

This philosophy will be applied to a data base management system as well. Small data bases and associated report generators will be created on small machines, then used in a variety of ways. First, the small computer will be a stand-alone processor, having no contact with a remote system. Next, it will be a node of a distributed system. Finally, the small machine will serve as an intelligent peripheral for a central data base computer.

Low-cost color graphics systems—the microcomputer combined with a high-quality commercial color TV—are of special interest to the Institute. These systems, typified by the Apple II, cost but a few thousand dollars. Coupled with data communications to a central data repository, such systems have the potential to make real what is now only discussed: widespread use of Federal statistical data via interactive graphics by states, counties, municipalities, public interest groups, and research groups. Obviously, a three-thousand dollar microcomputer and color TV will not provide the response time or visual quality of a thirty-thousand dollar, high-resolution display. Therefore, the creative challenge is to do the very best possible job with an inexpensive system.

Satellite Communications

Satellite communications offers unique possibilities for truly innovative uses of telecommunications. A single geosynchronous orbit communications satellite is electromagnetically "visible" to about one-third of the earth, and therefore, in principle, all persons and organizations within this illumination region have potential access to one another via the satellite. There are technical problems to be addressed:

- There is not enough spectrum to accommodate all the potential users of such a system if the allocations and use are in the normal, traditional mode.
- Ground stations are sophisticated and expensive.
- Satellites, as they are presently deployed, have limited suitable "parking" spaces in geosynchronous orbit, due to electromagnetic interference rather than physical space.
- There are major unsolved or partially solved problems in systems design and in technology to exploit fully the capabilities of the satellite as an "intelligent" node in a communications network rather than as a "trunk-in-the-sky."

Solutions will require the use of multiple spot beams with frequency reuse, satellite switching, digital time division multiple access and development of the higher end of the spectrum. These ideas are presently being planned for implementation in the Satellite Business Systems (SBS) satellite, XTEN (Xerox proposed network), and possibly ATT's Satellite System. However, some of the difficult technical issues of protocols and access techniques which maximize throughput and grade of service (availability, response time, etc.) require considerable new research.

In addition to the technical problems, there is the broader issue of how these satellite systems would be used. Should they be a common user network (like the telephone) or restricted, community of interest networks? What are the general public service needs that such satellite systems can provide? How should satellite resources (spectrum, space, utilization) be allocated? Should new communications services be provided? What are the economic and social ramifications of the new systems? Should direct satellite broadcasting be introduced in the U.S.? These and other issues will affect policy decisions and will also influence the direction of the technology.

RESEARCH PROGRAM III:

FEDERAL GOVERNMENT INFORMATION SYSTEMS—CIRCA 2010

At the highest level of government it is essential to know the "State-of-the-Union" in order to assess national trade-offs, to determine the feasibility of different kinds of interventions and the consequences of these interventions, and make relevant and accurate information available rapidly. Decision makers, policy formulators, and problem solvers will increasingly adopt and share the use of large information systems, as data banks fill with information and as the technologists develop the analytical skills, processing capabilities, and sophisticated models for the processing and display of such data. Information and analytical skills and tools will become more commonly available as government fully enters the information age. As we provide for the widespread use of data and analyses of this data, more and more people will have access to information: all levels of bureaucracy and all sectors of society, as well as the general public.

This research program will look at how the evolving information technology can be used to support organizational function and behavior; how the process of acculturation and learning the technology can be fostered; how organizational arrangements can be changed to take better advantage of the changing technology; and how incentives for sharing information and analytical methods among competitive groups in the policy-making process can be developed.

The purpose of this research program is to look ahead to the future, to forecast the setting in which information systems will assist decision makers at all levels of government, and to address the resultant problems and potential solutions which may accompany this technological advancement.

Government is an information-intensive enterprise, and many of its operations seek to relieve or redress natural or artificial imbalances in access to information. In our nation today, there are incentives to move from being an energy-based society to an information-based society. Home computers, electronic mail, cable television, and computer-controlled telephone switching systems are harbingers of a trend. What will happen to our forms of government when access to information and its means of manipulation becomes truly democratized? How will we choose to govern or be governed when each of us has equal opportunity to see what is going on in our country, and to prepare plural analyses of options for our future?

The concept of leadership in our government will surely be affected. When all levels of government and the general public have access to the data available to Federal decision makers, the question of leadership is raised. Should it always be assumed that elected officials and appointed administrators are better equipped to make decisions and formulate policy than the general public? At the least, it can be expected that many more groups of people and the general public will be "looking over the shoulders" of elected decision makers. The current assumption on the part of the general public that data and the skills to manipulate that data are only available at the highest levels of government will be dissipated with the introduction and use of computer-based information systems to support the public's participation in national decision making.

Research efforts will be necessary to adapt and refine existing models which describe organizational behavior to reflect the future. New models based on substantial changes in the way government operates will have to be developed.

Organizational and operating relationships among Departments in the Federal government, among the executive, legislative, and judicial branches, and among Federal, state, and local community governments may change as a result of widespread use of information systems for decision making. The consequences of changes to these well-established relationships are monumental.

In a sense, some elements of our governmental institutions have vested interests in maintaining the status quo. These elements owe their very existence to the maintenance of or control over discontinuities in access to information. Studies must be conducted on how to assist these elements to evolve into more productive roles as our information society evolves.

Such policy studies as these are best done outside of government, free from pressure and preconception, but close to government, in order to gain an understanding of the intricate nature of the way things work in Washington.

Management Without Paper

Paper pervades the operation of offices at all levels of society. With the growth of copying machines, governmental controls and regulation, and the natural desire of people to be informed, the use of paper has increased dramatically. As a medium for transmitting information, paper is inefficient and represents the loss of a natural resource at an increasing cost. Perceptive office management personnel have recognized the implications of the pervasiveness of paper in their operations and made attempts to reduce its importance. "Office automation," "the paperless office," and "electronic mail" are all harbingers of a possible revolution in the operation of an office.

Since paper is used to convey information in either a word format or graphic display, information systems based upon computers and utilizing data bases, graphic and alphanumeric displays, word processing, and telecommunications can conceptually replace much of the paper used in offices. The archival function, i.e., records in file cabinets, can be served by computer techniques which also provide rapid access to the information.

Some of the questions to be considered are:

- What is the impact on the functions of management without paper?
- Do styles of management and methods of directing organizations change?
- How is the selection, education, and development of management affected?

RESEARCH PROGRAM IV:

INFORMATION DISPLAY SYSTEMS RESEARCH AND DEVELOPMENT

The rapidly growing field of computer graphics plays a central and critical role in the development of sophisticated information systems. One reason for the acceptance of information systems is the ability of the user to perceive results rapidly and graphically. Computer graphics for information display allows policy makers and analysts to more easily and rapidly examine and absorb computer outputs, which, without graphics, often overpower man's limited ability to absorb column upon column of numbers.

Information systems raise a host of graphics display questions. Some of the challenges, such as alternative ways to depict geocoded information, the use of color, ways to present multiple variables, etc., are *graphics presentation* questions. The challenging *computer graphics* questions are ones of display system architecture, algorithms, storage structures, low-cost systems, distributed intelligence systems, graphics standards, and animation.

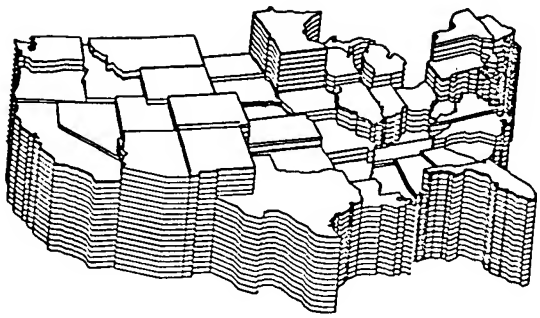
Long-term research in these two and other related subfields of information display will be necessary for additional technological breakthroughs and the understanding of the human-machine interaction in a variety of areas outlined below. The first group of research tasks addresses graphics presentations. The second group considers computer graphics, which is the hardware and software technology supporting the generators and consumers of information.

Information Presentation

The problem to be addressed by the Institute is the development of those various forms of display (maps, graphs) which will convey as much as possible of the information contained in the data accurately and meaningfully to the user. In describing approaches to the problem, cartography can be used as an example, recognizing that similar or analogous issues apply to other forms of graphics. The most important aspects of the display problem can be viewed in three areas.

First, color is one of the most powerful display tools. Cartographers have been using color for a long time, but little has been done to integrate the relatively large body of research on color perception with map design. This area would benefit from an interdisciplinary approach, including as it does elements of psychology, physiology, and graphics design.

A second area to explore is another powerful display tool, motion, which can be used to represent an additional dimension. For instance, time varying phenomena such as population growth or movement can be depicted in an animated display. Also, three-dimensional data presentations (see below) can be dynamically tumbled about to help the viewer perceive data relationships.



Work with color and motion leads to the third area of interest: development of new types of data presentations. In particular, capabilities for displaying many variables on the same map and displaying time series information need further development. This research also includes developing the capability to produce other types of maps (e.g., isopleth, dot, graduated symbol, three-dimensional, etc.) and perhaps to include sufficient intelligence in the system so that it produces the proper type of map given the type of data to be presented. At the least, the user should be warned when attempting an inappropriate display. The task here is primarily one of combining existing but widely scattered mapping capabilities into a coherent system. This is nontrivial, especially since users will want to operate in interactive mode, with fast response time needs. Most geo-based information display systems include only two-dimensional choropleth maps, which are not adequate representations of some data types.

It is important in this process to consider carefully the types and uses of displayed data. In developing a geographic information display system, government or private sources of historical and current primary data must be located and evaluated. At this stage of work, the methodology used to gather the information should be carefully examined and altered, as deemed necessary and/or feasible. Appropriate forecasting of scenarios for development of certain models, indicating possible future trends, may also be considered for inclusion in the data package.

Interdisciplinary teams will then establish guidelines for work assignments and select the sets of data which are to be used. In addition, areas of future concern and interest for policy makers will be determined. This task is often very difficult. However, such an effort can prove to be an invaluable guide in the policy and decision-making process; a crisis may otherwise catch administrators unaware and unprepared. The work of the Institute team will involve the targeting of incipient problems and trends before they mature or surface on a nation-wide basis. One of the assignments of the team, similar to that of a census users committee, will be to determine the types of new information that should be collected and to relay these findings back to the experts working on the gathering of primary data.

A cartographer will construct or help develop the visual display and a geographer will help to evalute this work, while a psychologist will measure impact on users. The following determinations will be made: Is the presentation overly complex or misleading? Does it focus the viewer's attention on highlights or on

trivia? Are spatial patterns easy to see? How long does it take for viewers to extract important information? How memorable is the message contained in the presentation?

The following are specific areas for developing new information display methods.

Projection Modeling

Economic-demographic simulation modeling is an important tool for analyzing current, future, and other hypothetical censuses. Such models are being used to examine changes in welfare programs, tax laws, school aid, CETA funds, and the distribution of other Federal formula grants. Research on information display at the Institute will aid in improving the clarity and usefulness of these models by supporting the communication of results. In addition, the Institute staff will develop generalized simulation tools which will facilitate the implementation of analytical models as computer programs. Another application, advanced dynamic displays of simulated community growth patterns, will be useful in analyzing traffic flow and congestion, provision of health, welfare, and educational services, and firefighting needs.

Interactive Data Analysis

There are many interesting research areas in the application of an information display system to data analysis. Each involves the visual perception of logical structures within a body of data which need not be restricted to geocoded information. One of these areas is the ability to augment data itself to display relationships which were not expected. Consider an example from some recent work on family formation. An economic theory was developed to explain differences in the marital status of women across the states of the U.S. A statistical test of the model was successful. Fortunately, however, researchers were prodded to look deeper into the data by examining residual variations after all the theoretical effects were accounted for. It was discovered that three states (Nevada, Utah, and Idaho) had higher than expected incidence of marriage and several states (Rhode Island, Connecticut, and New York) where the incidence was much lower. It was then possible to postulate an inverse relation between the incidence of marriage and the difficulty of obtaining a divorce. This counter-intuitive statement, while supported by the data, does not of course indicate a causative relationship.

Contemporary information display systems should have an integrated statistical analysis capability for model fitting and flexible procedures for displaying the relationships between the results of these analyses and other components of the data base. This requires a statistical package linked to both the data base and the graphics capabilities.

Microsimulation

Computer graphics is essential to the meaningful analysis of large bodies of disaggregated data. Reports containing dozens of pages of tabular data representations can be communicated by a single 3-D shaded computer graphic plot. Consider the simulation of the effect on the income distribution of a major tax change. Traditional summary statistics are very insensitive and tabulations of individual responses are unwieldy. A well-designed computer graphic presentation, perhaps with dynamic color changes, could easily display the effects of the change on several thousand representative families in one frame.

Display System Architecture

In the long-term, a top-down approach to the design of raster display systems is appropriate and necessary. Existing system designs tend to be more technology-driven than need-driven. A top-down design would stress functional requirements, hardware-firmware-software trade-offs, and ease of programming. A high performance architecture might have the refresh memory (bit map) as part of the host computer's address space, for ease of manipulation. The refresh buffer might contain more pixels than the screen can display, with video-rate zooming and panning. In fact, the encoding might not be a bit map, but some other form which facilitates picking, motion, and changes.

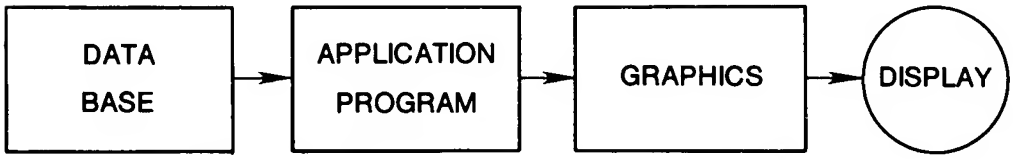
Raster system design for interactive graphics is still in its infancy. The overall intent of this Institute research is to use the paradigm of geographic information display to advance the state-of-the-art.

Animation Language

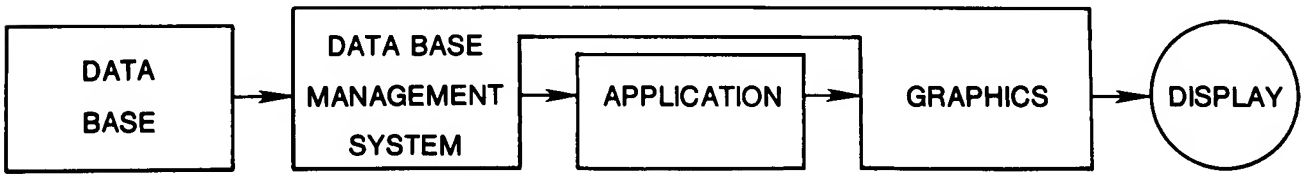
It is well-established that animation is a forceful means of conveying information. However, no cost-efficient means of creating animations of data presentations exists presently. Typical computer-generated animations are created at great expense. Institute staff will experiment with several approaches to simple animation command languages which can be used directly by the policy analyst without use of a computer specialist intermediary.

Graphics and Data Base Management System Integration

Most information display programs are structured as shown in the diagram below. Writing the application program necessary for an information display system is a slow and error-prone task. Part of the problem is that the application program must act as the intermediary between the data base and the graphics:



The Institute will develop a preferable program structure in which a Data Base Management System manages the data and, upon request, passes the data directly to the graphics in a self-describing form. This makes the application program smaller and simpler to write, thus facilitating the development of information display systems.



RESEARCH PROGRAM V:

RESEARCH IN HUMAN-MACHINE INTERACTIONS

As successive development efforts move to highly interactive computer-based information systems, the human-machine relationship becomes more important. Further psychological, sociological, human factor, and management insight into the nature of human use of computer-based information systems is needed. The kinds of tasks an operator can perform, response times, fatigue, emotional responses, and other dimensions of the relationship between people and machines become limiting and necessary subjects of detailed research.

This research will be conducted by an interdisciplinary team of computer scientists and psychologists. Computer scientists understand the capabilities that technology can provide, while psychologists understand how people can best interface to the capabilities.

User Interface Research—Long-term Goals

The Institute's long-term goal is to develop better methodologies for designing interactive systems, with an emphasis on the fact that the system must interact well with many users whose backgrounds vary widely.

The design methodology will be top-down, working interactively through designs at the conceptual, semantic, syntactic and lexical level. This four-step design process is useful because it serves as a conceptual framework to:

- Organize existing guidelines for designing user-oriented interactive systems;
- Impose discipline on a generally undisciplined field, which has too many aspects of art and not enough of science, while still recognizing the important role of creativity in the design;
- Organize existing knowledge from human factors engineering, cognitive psychology, and perceptual psychology so the knowledge is available to user interface designers;
- Demonstrate weaknesses in current knowledge of how to design user interfaces, thereby suggesting specific areas for further research.

It is not expected that those in influential policy-making positions will often interact directly with current-technology display systems at the operational level. They will act through technical intermediaries who are computer-literate. Therefore, it is productive to design the user interface for people who may have a good idea of what they want to do and need only be shown how to do it. Going one step beyond the current-technology systems, Institute researchers will also work with systems designed for the computer-naive users who want to access the full range of capabilities for retrieving, manipulating, and displaying data.

The Institute will first design a computer-aided tour of its developmental system's capabilities and a course of instruction in their use. This educational function will also facilitate extending the community of users. Second, the "proper" levels of hierarchical structure of data base documentation will be investigated. The hierarchy here is not the same as that of the data itself but rather levels of detail in the description of data.

Next, the data base should be made accessible within the syntactic structure of a high-level language. This would not only facilitate the ability of the user to generate individualized reports, but would also make possible substantive modeling and innovative statistical analyses. The menu approach is a useful initial method of inputting display requests. However, faster command input strategies for experienced users can rely on keyboard command languages, function keyboards, or tablets.

User Interface Research—Short-term Goals

The Institute's short-term goal is to develop user interfaces for a variety of information systems. The approach, the same as for long-term goals, is to work top-down, integrating application-oriented functional requirements and an understanding of user psychology and human factors.

The short-term design work will draw on the functional requirements developed by current evaluation of operational projects, by observing information display users in the Institute's laboratory, and by consulting with users and developers of other information display systems. The basic working hypothesis is that new users will find a menu-based user interface desirable, but that regular active users will want a command language system. It is also hypothesized that regular users will want to interact intimately and rapidly with the displayed image, perhaps using a tablet or a light pen.

User Hardware/Software and Other Technological Implements

Hardware/software support of the user interface encompasses many disciplines including graphics, systems programming, data base structure and design, human-machine interface psychology, and signal processing. The state of development of these disciplines varies widely. Speech synthesis, which depends on signal processing, is in a state of early development, as is the psychology of human-machine interaction. Graphics is further developed but represents only one side of the user interface. Supportive technologies such as data base management, languages to support interactive query of information files, and operating and input-output systems to support real-time operation of an information system, are all in need of further development dependent on fundamental research.

In order to develop the required technical support for improved human-machine interaction, the Institute will initiate a number of research efforts. A representative list includes:

- Design of user-computer interfaces employing graphics, keyboards, printers, and specialized "front end" languages;
- Development of relational data base systems to support query of related files required for demographic and cartographic analysis;
- Development of data structures to support the decision-making process most efficiently while minimizing the amount of storage required;
- Development and evaluation of distributed data processing networks to support interactive graphics between geographically dispersed installations;
- Development and design of security techniques to prevent unauthorized access to data files and use of enscryption and other techniques for the transport of data;
- Evaluation and design of networks to preserve security and privacy of information transmitted between locations:
  - Establishment of security measures
  - Cryptographic techniques
  - Special security protocols
  - Standards for transmission protocols and security designs;
- Development of device-independent and portable software to support all aspects of the human-machine interface. People want to learn only one interface, not a set of interfaces;
- Development of controlled experiments to measure the degree of comprehension by the person of the machine and vice versa;
- Development of organizational concepts, theories and practices, and behavioral sciences skills and techniques to use human systems' total resources.

RESOURCE CENTER:

ESTABLISHMENT OF INFORMATION CENTER FOR INFORMATION SCIENCE AND TECHNOLOGY

The Institute for Information Science and Technology will establish and maintain a Resource Center. This clearinghouse will serve as an index and repository for research information concerning information science and technology. It will also serve as a forum, a "center of intellectual exchange," where researchers can share knowledge on work in progress through an information exchange network. Three distinct services in particular will be provided by the Resource Center.

First, the Resource Center will be responsible for developing and maintaining a directory of expertise available nationally and internationally in the field of information science and technology. This register of experts will assist the Institute in selecting staff for its research positions, in identifying particular expertise necessary for contract services, and in maintaining a specialized audience to whom the Institute will disseminate findings of research programs. The register will be available for use by interested organizations, government, academes, and the general public. A search service will be available so that individuals or organizations requesting the identification of particular expertise in a selected field can be provided that information.

Second, the Resource Center will serve as a repository to prepare and maintain a compilation of suggested research needs and problems in the field of information science and technology which might be initiated by government. This list of "open problems" will be arranged in a taxonomic structure for ease of retrieval, indexing, and dissemination. Other research services, available to subscribers, will enhance the nurturing of a community of interest among researchers and practitioners in the field, as well as serve research interests at the Institute. The Resource Center will also serve as a forum for exchange of work in progress in the field.

Third, the Resource Center will be responsible for the preparation and publication of all Institute reports, papers, and other publications, and for the maintenance of an index of these documents. Publications include reports that present progress or completion of research activities underway at the Institute. The Resource Center will maintain a current mailing list of all individuals and organizations interested in receipt of such research findings and will be responsible for disseminating these findings throughout the research community. A monthly newsletter will be published.

The Resource Center will be a separate, self-funding cost center, and will play a focal role in the conduct of seminars and conferences sponsored by the Institute. Since all seminars and conferences have an educational dimension requiring access to information, the data base available in the Resource Center will be of interest to researchers in the planning of research projects, preparation of papers, publication of reports, and in the preparations necessary to conduct such education and training programs.

3. ORGANIZATION AND OPERATIONS

STAFF

The Institute is a contemporary laboratory in the sense that practitioners and researchers are brought together to focus jointly on the problem of user needs. There is a deliberate mix of permanent and adjunct staff: government, industry, and university staff; practitioners and researchers; senior researchers and students—a cross-fertilization of the spectrum of skills and roles that can be brought to bear on the issue of information science.

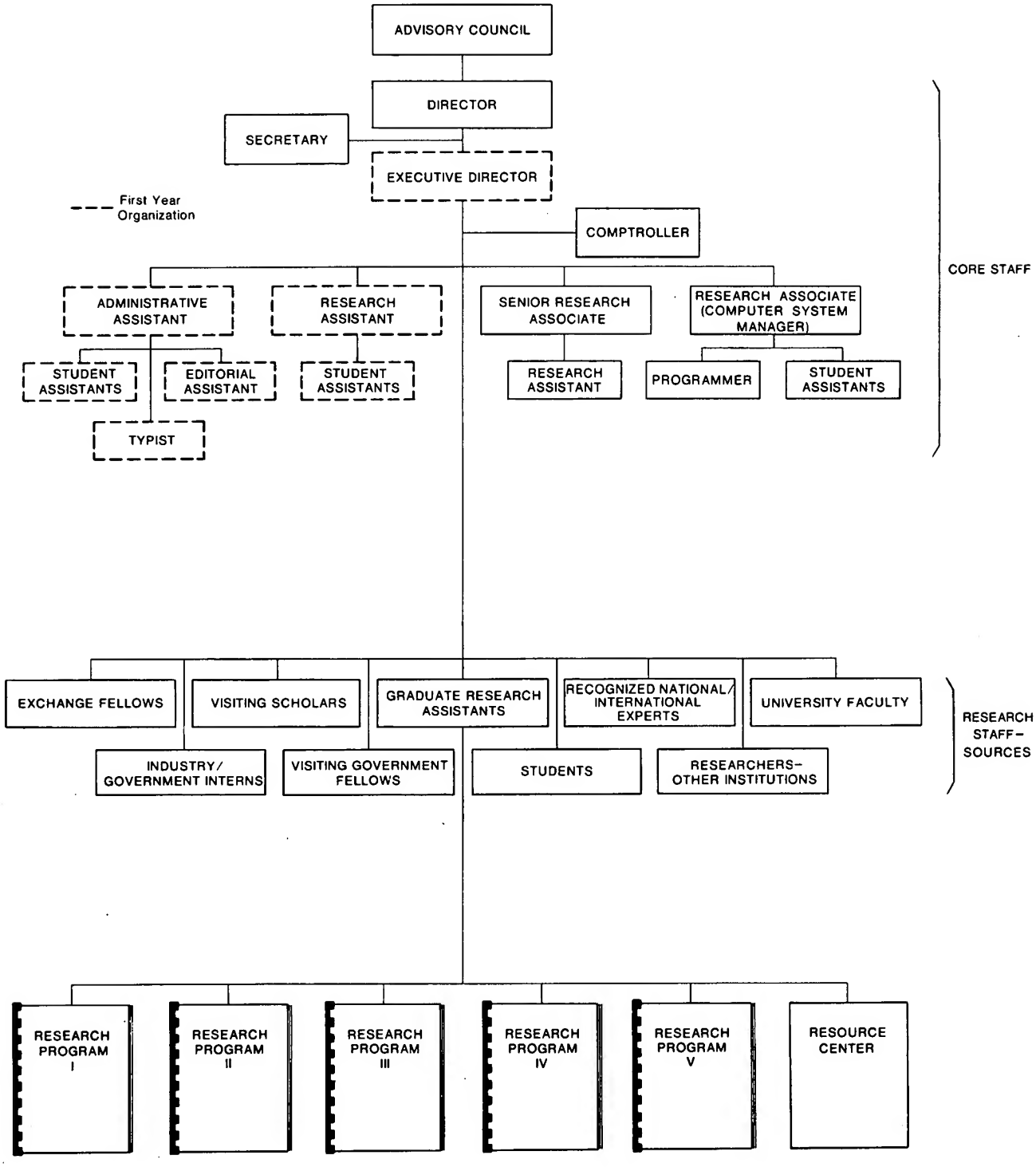
The core staff of the Institute will provide the organizational continuity which the degree of change inherent in the organization's format might otherwise threaten. The degree of flexibility and change characteristic of the rest of the staffing pattern is apparent, and a deliberate means of assuring the continual growth and development of the organization's capabilities is necessary. The majority of the research staff will continue on career tracks which necessitate constant professional movement; adjunct staff will be transient, continuing to move among government, industry, and academia; and students and consultants, by the nature of their positions, will be only temporarily involved with the Institute.

This staffing plan is a tool for interdisciplinary development and continuing education. The Institute provides a vehicle for the enhanced completion of undergraduate education as well as a unique research experience for well-rounded graduate students.

The initial Institute core staff will be maintained at a very modest level of five or six people: executive director, administrative assistant, typist, research assistant, editorial assistant, (and comptroller). Three student assistants are included as support staff. In the second and subsequent years, the core staff will be increased to twelve plus seven student assistants.

In addition to the core staff, the Institute employs an extensive research staff in both resident and adjunct positions. Six adjunct staff will be actively engaged in direct research efforts during the first year. In the second year this will be increased to eighteen persons, nine of whom may not be in residence at the Institute. The multidisciplinary research staff will be recruited from the following sources:

- Academic and research faculty from metropolitan Washington area universities
- Recognized national and international experts
- Undergraduate and graduate students
- Academic scholars and government executives on sabbatical
- Postdoctoral fellows
- Visiting government fellows
- Mid-career industry and government interns
- Researchers on exchange arrangements with other countries and institutions
- Other institutional researchers



Core Staff

Core staff are normally permanent full-time members in residence at the Institute's facilities. Among management and research positions are the following:

Director—Responsible for overall Institute programs and policy decisions, and specifically spends substantial time and energy on senior staff selection, planning and policy formulation, and the successful completion of endowment funding and financing needs.

Executive Director—A technical manager responsible for the general management of Institute programs and administrative operations including planning, organizing, staffing, controlling, evaluating, and proposal activities.

Senior Research Associate—A senior researcher who may be responsible for a major research program or the independent study of a portion of a major research program with supervisory responsibilities.

Research Associate—A mid-career person who may work as an individual contributor responsible for major research efforts, or who participates as part of a team effort.

Research Assistant—An individual below the doctoral level who may be a graduate student working toward a doctorate, normally contributing under the supervision of a senior staff member and under the guidance of a faculty member in the case of those preparing dissertations.

Student Assistant—Usually part-time or temporary staff, below the bachelor's level, engaged in a myriad of research and administrative tasks.

Research Staff

Research positions include both resident and adjunct positions; that is, the researcher may be in residence at the Institute or contribute from residence at a sponsoring organization. In addition to core research positions described above, other appointments are as follows:

Visiting Scholar/Fellow—The Institute's highest research position, with limited appointments for one to two years. Visiting scholars and fellows are in residence at the Institute and may be academic faculty or government Senior Executive Service staff on sabbatical.

Adjunct Fellow—A senior researcher, not in residence at the Institute, who will make contributions to research programs, but will not have supervisory responsibilities.

Adjunct Research Associate—A similar position to the Adjunct Fellow, for persons mid-career in background and experience.

Consultant—An individual with a particular expertise necessary for the Institute's research program. Consultants will be commissioned for periods of up to one year and may reside at the Institute during this period of study or may remain at parent organizations.

Intern—A mid-career person from either government or industry selected to work in residence at the Institute for a period of one year, and in some instances as long as two years. Interns are selected on the basis of promise for future research capability and constitute a valuable resource of eager young workers who can execute many useful though not necessarily technically demanding tasks within the Institute's research plan. Interns are encouraged to pursue courses of graduate study during their internship.

ADVISORY COUNCIL

The Institute, in consultation with university, government and industrial leaders, will establish a national Advisory Council for the Institute during fiscal year 1980. The Advisory Council will consist of fifteen persons of prominent position or experience in government, industry and academia. The Advisory Council will offer broad policy guidance and function as a reviewing board to ensure that the technical activities of the Institute are of the highest overall quality consistent with the stated mission of the Institute. To ensure continuity of operations, the initial Advisory Council members will be selected to serve for staggered terms of one to five years. The President of the George Washington University and the Director of the Institute will be ex-officio members of the Advisory Council.

The Council will meet three times a year in full session to review details of the development plan, financial reports, and progress on research programs, to provide guidance in the initiation of research activities, and to review completed research results.

The Advisory Council will have the authority to establish committees which may be used in specific reviews and in more detailed consideration of individual Institute research activities. Advisory Council members participating in meetings and activities will be reimbursed to allow for travel, lodging, and meeting arrangements, and will receive a modest annual stipend. The director of the Institute for Information Science and Technology is responsible for providing a written annual report to the Advisory Council describing the preceding year's activities.

UNIVERSITY RELATIONSHIPS

The Institute for Information Science and Technology, initially formed by the Department of Electrical Engineering and Computer Science, will be administered by the George Washington University School of Engineering and Applied Science. The Institute will maintain a small permanent core staff with active linkages to all universities in the Washington metropolitan area.

The George Washington University has the largest faculty, student body, and research facility in Washington, D.C. Its long history of government research work and immediate proximity to government agencies make its selection as the "parent" of the Institute ideal. Further, the Department of Electrical Engineering and Computer Science will provide heavy technical input for systems development, computer sciences, and laboratories and computer facilities as well as equipment support in the form of computer services, computer graphics laboratory, and use of conference rooms and lecture halls.

There is a wide variety of technical expertise in the Washington metropolitan area which can be obtained through government exchange programs, industrial fellowships, and research scholar arrangements. Individuals working cooperatively with university faculty and research staff provide a broad range of technical capabilities to carry out studies and research in information science and technology. Working through the University, the Institute can conduct joint ventures and cooperative projects with other universities, research organizations, and industrial organizations.

The Research and Resources Office within the School of Engineering and Applied Science provides services to the Institute including budget control, payment processing, and proposal review. The Office of Sponsored Research provides legal, contractual, and management services. Office facilities are provided on campus with secretarial, reproduction, communication, and report preparation support.

The field of information technology is growing so rapidly that the number of undergraduate and graduate students majoring in computer science is insufficient to meet current demands. The Institute's affiliation with The George Washington University School of Engineering and Applied Science and other universities serves as a vital stimulus in meeting the needs of government and industry for such graduates.

The student population at George Washington University consists of a relatively stable undergraduate population and an extensive graduate student population including a large number of students from industry and government agencies in the Washington area. The University sponsors off-campus programs at nearby government agencies, most prominently NASA Langley. This affords beneficial interaction between industrial and government agencies and the University. This interaction will provide access to a large number of graduate students who can carry out thesis research under the sponsorship of the Institute. Conversely, this interaction also leads to knowledge of problem areas within the government that can benefit from research activity carried out by the Institute. The interaction between the University and industry and government agencies provides a vital linkage to support the Institute in the role of basic research in information science and technology.

EQUIPMENT RESOURCES

In addition to personnel resources, the George Washington University offers a broad spectrum of conveniently located physical and support resources. Facilities exist for conducting workshops and meetings and adequate housing is close at hand. Support facilities include a library and recreational facilities, duplicating and communication support, and secretarial and administrative capability.

Extensive resources at The George Washington University will support many of the anticipated demands of the Institute for Information Science and Technology. The University computation center has an IBM 3031 with 3 million characters of main memory. There is also a DEC PDP 11/70 with thirty-two terminals, operating the WIDJET system for interactive programming.

The School of Engineering and Applied Science has developed a modern and well-equipped computer graphics laboratory available to the Institute. A DEC VAX 11/780 medium scale computer with 2.5 million characters of main memory serves ten program development terminals. Low-resolution graphics is provided by three Tektronic 4010 and 4012 terminals and a hard-copy unit.

There is a high-resolution Ramtek 9400 color raster display capable of displaying images with 1,000 scan lines with 1,280 pixels of ten bits each. A picture can include up to 1,024 different colors. The resolution is approximately ten times greater than that of a home color TV. The color maps shown in this development plan could be generated on the Ramtek 9400. A film recorder connected to the display will make 8″ × 10″ Polaroid or 35mm film photographs of the contents of the screen with no resolution loss; users of experimental systems will be able to keep a record of their work for later reference, presentation, and publication.

For black and white line-drawing graphics there is a Vector General 3404 three-dimensional display, useful for real-time dynamic display of time-varying data or for "flying" through and around multi-dimensional scatter plots, response surfaces, and other data presentations.

PROCEDURES

Detailed research plans for each major program, including schedule and budget levels, are established by a consortium of Institute core staff, resident research staff and adjunct research staff representing the relevant disciplines under study. The consortium then identifies the most appropriate available researcher to serve as principal investigator; this principal researcher is often not a member of the resident Institute staff.

The Institute may commission individual faculty, research staff, or university departments to participate in specific research activities. In some cases faculty from the University will be designated as the principal investigator on a research project; in other cases Institute staff or acknowledged authorities at other institutions may be the principal investigator, and researchers from other fields will assist on the project.

When required, a team of international experts will be assembled to address a specific research program or review earlier findings with a view towards continuing research efforts.

During the first year of operations, the Institute staff will concentrate on five central activities.

First, the Institute's executive director and administration staff will be selected. Office space will be secured to house the staff. The core staff will develop a series of proposals for the initiation of specific research programs.

Second, the Institute will develop brochures and print technical pamphlets announcing its formation and the availability of the research positions for visiting scholars, interns, and fellows. These announcements will be distributed to a wide audience in government, industry and academia.

Third, the research program of the initial five-year plan, Volume II, will be completed in sufficient detail to demonstrate research task interrelationships. This document will be a "living" research plan for the Institute—in daily use and undergoing continuous modification and expansion.

Fourth, members of the national Advisory Council will be identified and their commitment to participate will be obtained.

And last, Institute staff will continue efforts to meet the endowment fund goal. Visits and presentations will be made to a number of foundations and industrial corporations identified as potential funding sources.

Initial research efforts budgeted at approximately $400,000 are already underway. Portions of the research plan outlined in Section 2 are being implemented, and approximately $100,000 of initial research equipment will be purchased.

EDUCATIONAL PROGRAMS

The Institute will conduct a variety of education and training programs. Many seminars and colloquia concerning Institute research activities will be held. Graduate students at the master's and doctoral levels and visiting scholars and postdoctoral students will be invited to participate in the Institute's educational activities. Members of the Institute will be expected to circulate among private industry and government organizations to disseminate research findings and techniques concerning information systems for support of decision making and policy making. Institute staff will be encouraged to attend professional meetings and seminars and to disseminate research activities as they occur as well as research findings when complete.

Educational programs conducted at the Institute will be largely short-term in duration, but may range from a one-day conference meeting or seminar, to a one-year residency for an intern. Government agencies involved in information systems, particularly those providing sponsorship to the Institute, will be invited to select promising mid-level staff to participate in these programs. Scholars from universities and industry participants will also be invited to take part in the Institute's educational programs. This richness of backgrounds and experiences will create the potential for significant interchange of ideas and experiences between all sectors of society concerned with research and utilization of information systems.

A broad range of educational opportunities also exist at the undergraduate and graduate levels of the many educational institutions in the metropolitan Washington area. Many cooperative arrangements exist among these universities, expanding the range of unique training opportunities available. Interns and research scholars who participate in the Institute will take full advantage of such training and educational opportunities.

In addition to their research activities at the Institute, interns will be encouraged to continue their graduate education. Upon completion of their internship and associated graduate studies, they will return to industry and government well-trained in both academic and pragmatic areas of research in information science from an interdisciplinary approach.

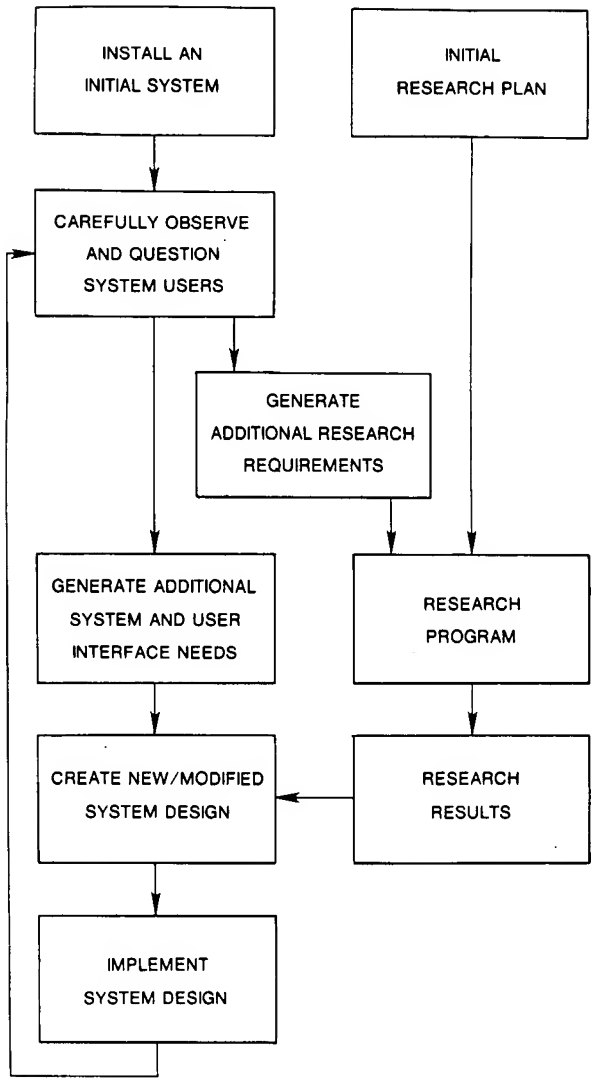
SYSTEM DEVELOPMENTS

Integrated network systems are central to the Institute's information science research. As one initial system development effort, the Institute will design, build, and use a series of information display systems. The first system, however, will not be an original design of the Institute. Rather, an existing system, such as DIDS, SEEDIS, or ODYSSEY, will be adapted to work with the Institute's computer equipment. Intensive use of the system by policy analysts from universities, Federal agencies, and other sponsoring organizations is anticipated. Researchers will observe how the system is used, which features are used, and which features are mastered and made productive.

Armed with this initial experience, and with experience from users of other systems and research efforts, the Institute will design and implement new information display systems. Users will then move from the original system to the new one. A cycle of modifications will be made over a period of several years to the internal or external characteristics of the system.

Several research programs outlined in Section 2 will be responsive to the general requirements of information display systems. At the educational level of Institute programs, information display systems will serve as a focal point for teaching policy analysts how such systems can be fruitfully used, and to teach computer technologists the techniques used in implementing such systems.

INFORMATION DISPLAY SYSTEM DEVELOPMENT



4. CAPABILITIES

The capability for innovative research and problem solving depends on a pool of knowledge and ideas from many disciplines. The greater the variety of fields involved, the greater the likelihood an optimum combination will occur. A researcher from a given discipline will bring patterns of thinking and information not available to specialists from other fields. A broad array of education, experience, and fresh perspective is more likely to foster a significant research advance than individual experts working in a single discipline.

The Institute for Information Science and Technology is conceptually based on the principle of bringing a wide range of disciplines to bear on any of the research activities pursued within the Institute's programs. This interdisciplinary approach allows the Institute to conduct research in information science and technology with a "systems" or holistic approach.

For example, in the area of computer graphics to support policy making, it is necessary to utilize computer graphics, geography, political science, and statistics staff to address this task adequately. In another area, economic analyses and forecasting, there is a requirement for economics, mathematics, and data processing skills in order to address the issue comprehensively. In still another example, the question of urban planning issues requires geography, cartography, sociology, psychology, and demography disciplines for adequate study.

The following fields of interest or discipline areas have particular applicability to the design and use of information systems to support the decision and policy-making process. The list below is an administratively convenient way of grouping the disciplines into distinct categories, and is followed by a brief description of some capabilities and fields of interest which will be brought to bear on Institute research.

- Science and Engineering
  - Computer Science
  - Data Communications
- Operations Research and Applied Mathematics
- Statistics
- Management
  - Management Science
  - Business Administration
  - Public Administration
- Policy Studies
- Law
- Political Science
  - Government
- Urban/Regional Planning
- Education
  - Human Development
- Economics
  - Econometrics
- Psychology
  - Human Factors
  - Cognitive Psychology
  - Perceptual Psychology
- Sociology
- Geography
  - Cartography

The capability statements appearing hereafter are not a complete compilation of available disciplines, but rather a representative listing.

TELECOMMUNICATIONS

Telecommunications technology serves as the backbone of any distributed data processing system. Such systems are required to support interactive graphic displays, interoffice communication, and decision making based upon access to remote data. Capabilities include:

- Design, development and analysis of computer communication networks including but not exclusive to the following:
  - Topological optimization
  - Response time and throughput
  - Performance
  - Error control
  - Data compaction and source coding
  - Computer netting protocol
  - Transmission systems
  - Technological innovations
- Evaluation and design of networks to preserve security and privacy of information transmission.
- Design and implementation of telecommunications security in office autoprocessing networks.
- Evaluation of teleprocessing networks with respect to performance parameters such as:
  - Network transmission reliability, bandwidth, transmitting media, and network transparency
  - Cost/benefit analysis of alternate network design and security techniques
  - Network reconfigurability capability
  - Network modularity
- Study and design of innovative network architectures based upon anticipated new technological developments such as:
  - Packet switching vs. fast digital circuit switching
  - Fiber optic data loop switched systems
  - High capacity/small earth terminal digital satellite systems
  - Innovative uses of the telephone network for interactive video and data

ENGINEERING SUPPORT TECHNOLOGIES

Engineering support technologies include those aspects of computer science and electrical engineering which provide the underlying design technology for such disciplines as graphics, data base management, human-machine interactions, word and text processing, and data communication and security. The fields of electrical engineering and computer science provide a wide range of engineering technology capabilities to the Institute, including:

- Development and use of software design tools including compilers, assemblers, input-output control systems, data dictionaries, debuggers, and program library systems.

- Development and use of hardware design tools including logic design programs, printed circuit layout programs, configuration control systems, and digital test systems.

- Design and development of software design methodologies to support structured programming, requirements definition, and automatic programming.

- Research to develop software "proof of correctness" algorithms to verify software designs.

- Development of specialized software to serve as "front end" languages to interface users with computers via keyboards, and alphanumeric and graphic displays.

- Use of fault tolerant system design techniques to support all aspects of hardware and software design used in information systems.

- Development and use of self-diagnosis reconfiguration and checking procedures to provide fail-safe system operation in the face of component failure.

- Development of new computer architectures to support data base management, graphics interfaces, distributed data processing networks, and parallel processing arrays.

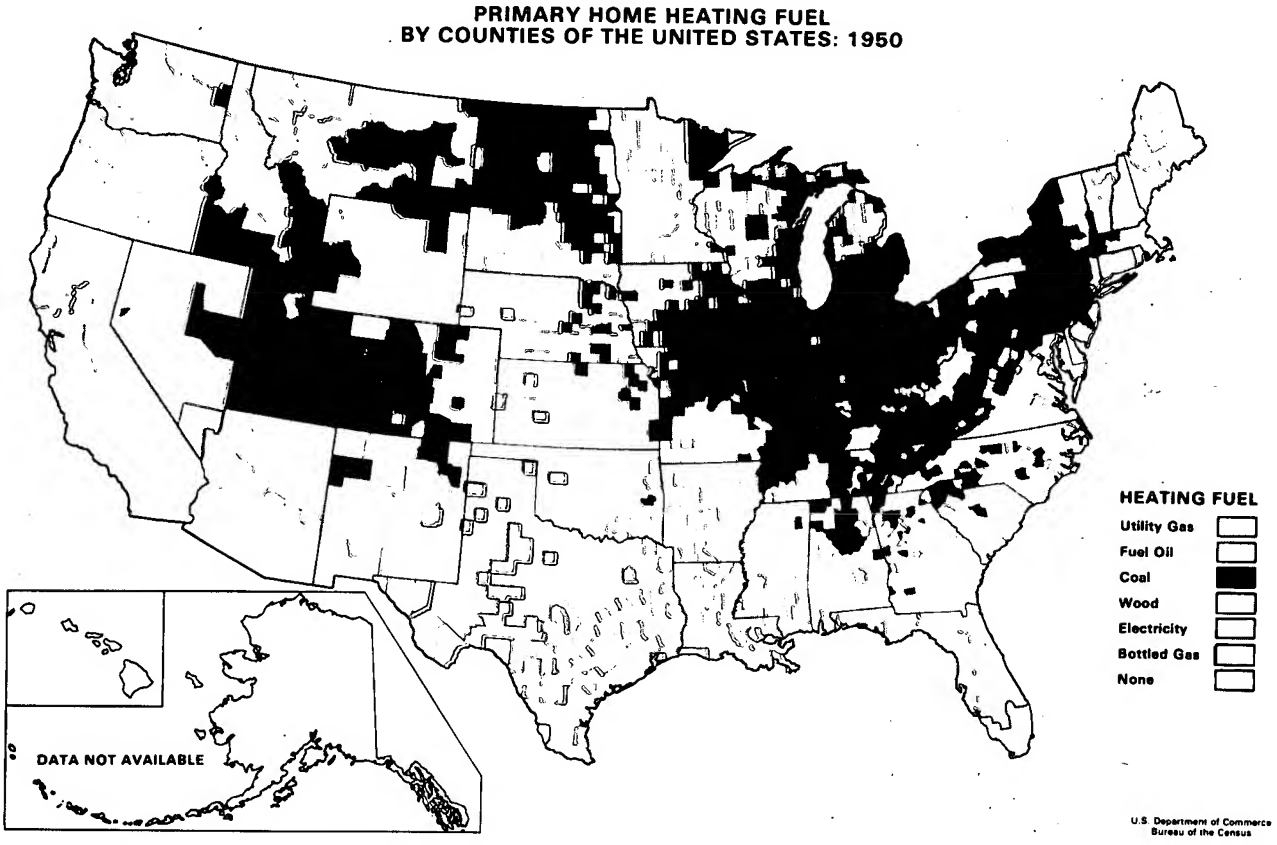
- Development and use of micro-computer technology; in particular, bit slice architectures to support all aspects of hardware required for graphics, data base management, software development tools, etc.

COMPUTER GRAPHICS

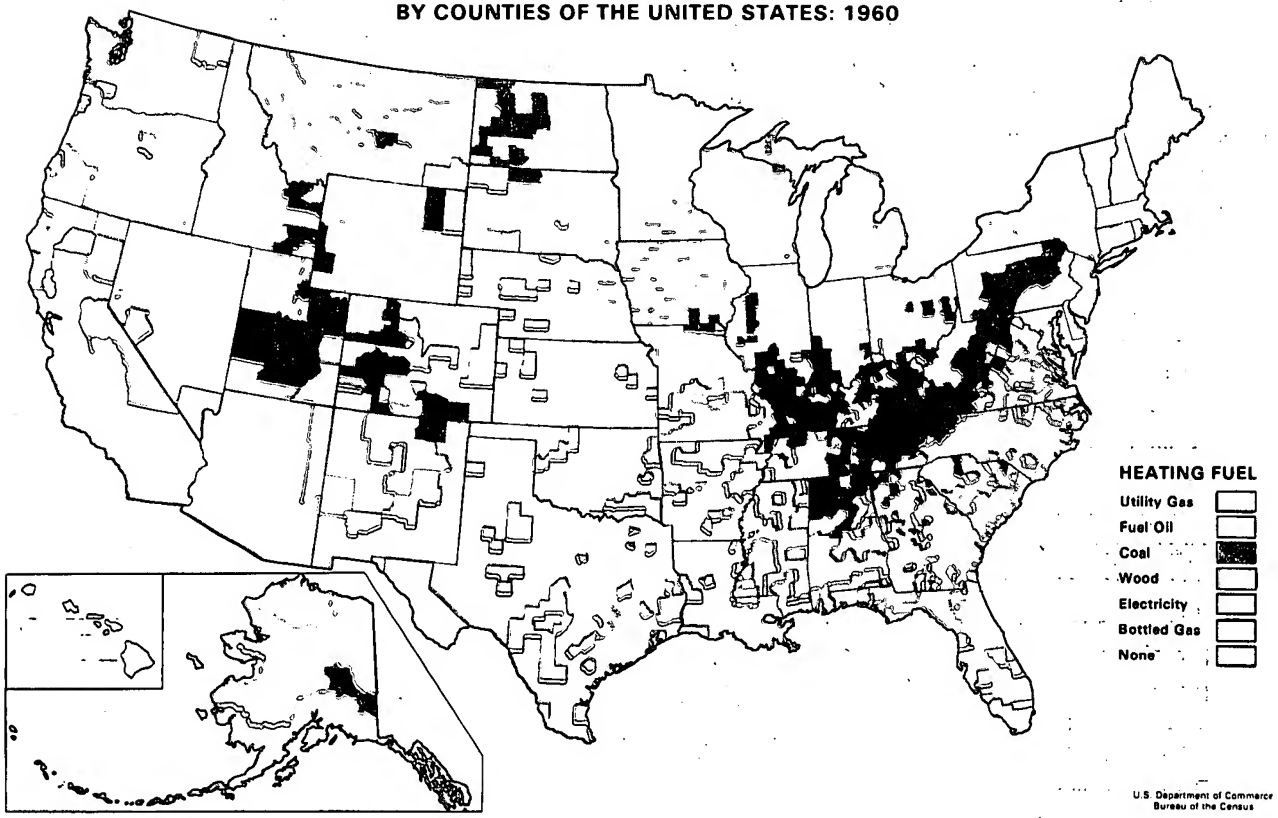
Computer graphics will play a central role in offices of the future and in decision-making procedures. A wide range of capabilities exists in support of graphics research, including a well-equipped laboratory with the latest, most sophisticated equipment. Some specific capabilities include:

- Development of interfaces between graphics and data management systems
- Design and development of parallel processing techniques to support hidden surface removal
- Experiments to evaluate the techniques developed for the above
- Design of architectures to support vector and raster graphics

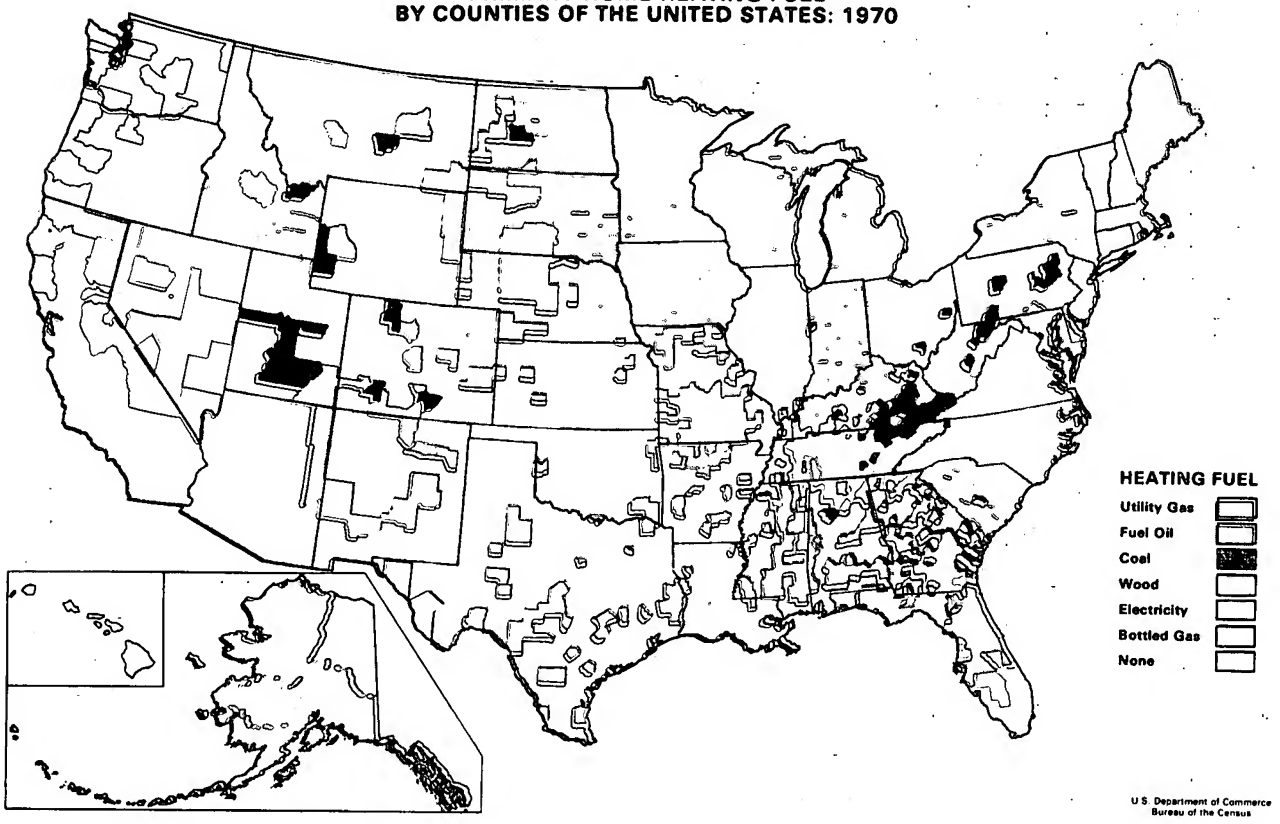
An old saying of Confucius has a current equivalent: "A picture is worth a thousand numbers." Pictures, in the form of charts, graphs, and maps, are one of the best ways to convey information to policy makers and policy analysts quickly and succinctly. The role of computer graphics is to create pictures such as these which show the move in home heating from wood and coal to gas and electricity. These pictures are worth rather more than a thousand numbers: each represents values for the 3,106 counties in the United States.



**PRIMARY HOME HEATING FUEL
BY COUNTIES OF THE UNITED STATES: 1960**



**PRIMARY HOME HEATING FUEL
BY COUNTIES OF THE UNITED STATES: 1970**



DATA BASE STRUCTURE AND MANAGEMENT CAPABILITIES

Data base structure and management play a central role in the design and use of information systems. Some specific capabilities necessary and useful for Institute research are:

- Development of data structures to support graphics systems and user machine interfaces.
- Development of relational data base systems to support query of related files required to support demographic and cartographic analysis.
- Development of data structures to support the decision-making process most efficiently while minimizing the amount of storage required.
- Development of specialized techniques required to store large sparse matrices and large data bases acquired from census and industrial reports.
- Development of techniques and safeguards required for the transborder flow of data.
- Design of data bases to support specialized graphics requirements, including suppression of hidden lines, three-dimensional displays, and transformation and rotation of displays.

PRIVACY AND SECURITY IN INFORMATION SYSTEMS

Privacy and security techniques play an important role in the design and use of information systems. Privacy issues stem from the demands of public and governmental sources to protect personal information in computer systems. Security issues are motivated by the users of data processing equipment who want to comply with privacy laws and protect their data from unauthorized access. Some specific Institute capabilities include:

- The examination of whether microprocessors and distributed microprocessor systems enhance or degrade the security of present or planned computer systems.
- Development of cost/benefit analysis techniques to determine the costs and benefits of privacy and security protection for computer installations and distributed data processing systems.
- Use of non-numeric metrics to enhance the quality of risk-benefit analyses and social impact analyses.
- Security analysis of computer networks with large numbers of unsophisticated users and terminals, such as those used in electronic mail, point of sale, and electronic fund transfer systems.
- Analysis and evaluation of present or proposed privacy law and regulations from technical and administrative points of view.

MANAGEMENT SCIENCE

The field of management science provides a significant input in the design and implementation of information systems development, business applications, and research and development management. The field may contribute the following different capabilities:

- Management. Management thought, functions, practices, theories, concepts and philosophies as applied to all types of agencies and institutions; contemporary issues such as general systems concepts and contingency management, and program management are featured.

- Administration of Science and Technology. Technology influencing research and development management, business and public policy; employment of "state-of-the-art" technology, and creation of new technology through research and development (R&D); management of creative professional people; emphasizes original research on political, economic, sociological, and operational problems encountered by management in industrial and governmental R&D organizations.

- Human Systems. Organizational concepts, theories and practices; behavioral sciences skills and techniques to use human systems' total resources; designing, creating, and developing necessary behavioral and organizational systems appropriate to rapidly changing society; emphasizes interrelationships of motivation, leadership, problem solving, organization growth, organization complexity, and organizational changes and development.

- General Systems and Organizational Cybernetics. Interdisciplinary mode for understanding the increasingly complex systems which result from human systems that tend to grow larger and more complex as social and technological changes accelerate at a rapid pace.

- Information Systems Technology. Manual, mechanical and electronic information processing; computer programming concepts, methods, languages; capabilities, limitations, and selection procedures of equipment; all phases of management information systems development, implementation, and evaluation; and roles of management and technicians in information technology.

- Quantitative Analyses for Decision Making. Quantitative or mathematical approaches to problems of managerial control and decision making; basic theory, combined with various contemporary approaches such as simulation, decision-trees, PERT, linear programming, queuing theory, etc., are utilized.

- Interdisciplinary Approaches. A systems approach to management obtained by interdisciplinary combinations; for example, the fields of management, computer and quantitative science combine to provide solutions to specific management problems using mathematical simulation techniques on the computer; another example of the interdisciplinary approach is the combination of management, human systems, information systems, and sociology to resolve management problems in the areas of personnel and organization.

POLITICAL SCIENCE

The field of political science provides three basic types of resource support to the Institute for Information Science and Technology:

- Methodological Skills in Collecting and Analyzing Political Data. Identification of sources of data and their utilization to understand, evaluate, or project political developments and substantive policies is the initial requirement that the Institute resources meet; data analysis skills range from the more traditional descriptive to the more sophisticated and rigorous statistical manipulations of aggregate data.

- Knowledge of the Structure and Processes of Domestic and Foreign Governments and International Agencies. Although the range of coverage is extremely broad, specialized expertise is ordinarily limited to major foreign governments, international agencies, and regional systems; however, the commonalities represented in regional governments, states of political development, or ideological types provide a framework, together with the methodologies described above, to examine more precisely individual governments and agencies; the economic and social environments in which the government and public agencies operate are also involved.

- Knowledge of the Substance of Major Domestic and Foreign Policies of the U.S., Major Foreign Governments, and International Agencies. The range of coverage again is broad, although the focus of specialized expertise is ordinarily that of the U.S., major foreign powers, and international agencies; sufficient commonalities exist by government types to offer a framework to study more specialized policies of minor powers and international agencies.

EDUCATION

Understanding how people learn, and in particular how they learn to communicate, is an important capability contributing to all Institute research efforts. In an effort to improve the general acceptance and usefulness of computer-based information systems, the Institute will draw on the field of education to accomplish three objectives:

- Educate policy makers and other end users of data in how information systems can serve their purposes and in what types of data are needed and available.
- Educate analysts and data-providers (those who daily and actively use information systems and serve policy makers) in relevant policy areas, decision-making techniques, and computer concepts.
- Educate developers of information systems.

The Institute has the capability to increase the awareness at all levels of what things can or cannot be done, and to increase the efficiency of communication from policy maker to analyst to computer, and vice versa.

LAW

The field of law supports Institute research in many direct and indirect ways. Specifically, the legal profession can contribute to information science research through knowledge of:

- Government grants and contracts
- The decision-making process
- Government regulations and program administrative guidelines

Legal researchers trained in methodical, organized, adversary procedures will assist in developing a greater understanding of the government decision-making process and the role of information systems in this process. For example, as more official government business is conducted through and documented by electronic media, attention must be given to reassessing the legal status of nonpaper records. Also, decision-making rules and the Executive Branch officials responsible for making decisions are mandated by legislation in some cases. The Institute's legal researchers recognize such requirements in the application of modern information systems to decision making.

Since the field of information science is relatively new, no body of laws to govern information use has yet been developed. Surely new laws for control will be created. A new body of information laws is needed to permit an increase in the flow of information while continuing to provide individual and organization privacy and protection. The collaboration of lawyers and scientists to address this need represents a powerful synergy.

ECONOMICS

Economists serve the Institute in a variety of ways in both macro and micro aspects of the field. In macro policy, economists have expertise in productivity analysis and growth policy, dynamic equilibrium modeling, and stabilization policies, both monetary and fiscal.

At the macro level, policy choice and evaluation via optimization techniques and cost/benefit analysis is a valuable input to information science. In the subject area of public finance, economists conduct analyses of the impacts and effectiveness of particular expenditure programs and of specific taxes. In the broad area of human resources, economists have the expertise to evaluate education and training policies and programs, manpower development programs, and policies affecting the functioning of labor markets.

In the area of natural resources and environment, economists provide analysis of the impacts of natural resource depletion, the impacts of environmental regulation, and of the complex trade-offs between environmental quality, energy availability, access to an adequate resource base, and economic growth. In an urban context, economists analyze problems and policies in transportation, housing, poverty, urban renewal and development, as well as the regional distribution of population and economic activity. Nearly all economic problems, policies, and programs have an urban as well as a national dimension. At the level of the firm, economists can evaluate the functioning of markets for goods and services, the impacts of different kinds of regulation on behavior of the firm and industry, incentives and deterrents for investment, innovation, and competition, and issues of information about products and services and consumer protection.

The application of economic analysis to public policy is so extensive that representation of the discipline at the Institute is essential. Public programs are almost never begun or altered without contributions by economists to such issues as program cost, distributional impacts, and equity. Economic modeling is extensive, with diverse simulation methodologies complementing the widely publicized econometric forecasting approaches. In addition, economic theory underlies efforts to clarify our understanding of prices, wages, and productivity.

Economists contribute to the Institute as analysts with experience in the application of econometric modeling and related computing tools to policy-relevant research. These analysts are also a part of a user base adapting experimental tools in computer graphics, data manipulation languages, etc., to policy problems. They provide incisive critiques of system designs since they are actively engaged in what is for them "real" work.

GEOGRAPHY

Areas in which the discipline of geography contributes expertise are as follows:

- Urban Affairs. Urban land use, metropolitan area planning, settlement patterns, sequential occupance, diffusion schema. Use of remote sensing to determine land use change.

- Hazard and Pollution Perception and Control. Distribution, typology, occurrence and perception, use planning controls.

- Resource Management and Conservation. Energy sources and use, minerals, water management. Use of remote sensing.

- Demography. Population distributions, densities, characteristics (age, sex, race, education, income, health), migration streams, labor force analysis, employment and underemployment.

- Industrial Location. Spatial factors influencing distribution and other characteristics of industry.

- Regional Planning. Holistic geographer appraisal of areas. Spatial identification of poverty pockets.

- Political Geography. Spatial patterns of political phenomena (voting, representation, legislation); law enforcement.

- Climatology. Occurrence, patterns, relationship to agriculture, influence on land use.

- Agriculture. Regional distributions, densities, production, spatial characteristics. Holistic appraisal of agricultural regions. Food-population balances.

- Cartography. Techniques of presentation of spatially identifiable data (thematic map design).

POLICY STUDIES

The Program of Policy Studies in Science and Technology at George Washington University has twelve years of experience in multidisciplinary research in the requirements of restructuring information so that it can be understood and used by a wide range of policy people. This experience with the communication of policy information provides tangible insight into the system's requirements from the perspective of its many users. System definition, demonstration, evaluation, and adaptivity all need to be considered in terms of the needs of the professional policy-making environment. The Institute presents an opportunity to take an important step in the evolution of information systems to assist the policy process based upon a closed test facility and its applications.

The Program of Policy Studies' Behavioral Studies and Education policy group has expertise in social, clinical, communication, and computer-assisted information technologies for education and training. Observation of related psychological and contextual factors promises to improve information systems performance. The behavioral studies group has performed studies and analyses of user needs in information technology, education, technology utilization, energy, and transportation areas.

The Technology Assessment group specializes in identification and evaluation of the potential social, environmental, economic, and demographic impacts of technological innovations; in social forecasting; and in applied futures research. Recent studies have focused on customer thermal energy storage systems, electronic message delivery systems, modular integrated utility systems, materials information systems, transportation systems, retrospective technology assessment experiments, the future of small rural communities, and an update of technology assessment activities in all Federal agencies.

The Legal and Institutional Studies group specializes in analysis of legal and institutional aspects of emerging and existing technologies and in problems associated with legal and regulatory decision making. Recent studies include legal-institutional implications of wind energy conversion systems development; a survey and analysis of state land use controls; drafting of model ordinances related to auto and motorcycle noise based on synopses of U.S. and foreign statutes; and the role of state governments in the regulation of civil air carrier airports for the purpose of noise control.

PSYCHOLOGY

A major thrust of Institute research is the design of user-oriented interactive computer systems. Psychologists understand people, and can bring that understanding to bear on the design of interactive computer systems. Several subdisciplines which are especially relevant here are cognitive psychology, perceptual psychology, experimental psychology, and the applied psychology of human factors engineering. Cognitive psychology helps us understand how users acquire, organize, and retrieve information within their own information system—the human mind. Perceptual psychology helps explain how users see information displays. Experimental psychology brings us specific experimental results plus the methodology to test hypotheses about the users of information systems. Human factors engineering applies psychology (and physiology) to the detailed design and layout of user devices and data presentations.

One of the goals of interactive systems is symbiosis between the user and the computer, wherein the user becomes unaware of the details of communicating with the computer and hence becomes involved in the problem-solving process. While this result is rarely completely attained, it represents a significant design goal.

The principal task of the user-computer dialogue designer is to adapt the computer to the user, by studying the way the user works and processes the information the computer presents. This exacting research can result in easy-to-use, "user-friendly," computer systems which bring substance and reality to the often unrealized potential of computers to aid in policy analysis and decision making.

SOCIOLOGY

The sociology of science, of social stratification, and of formal organization all contribute to Institute research on information science. The uses and consequences of science and technology must be considered when developing new information systems. The incorporation of those designs into offices with information networks must take into consideration existing personnel and organizational relationships. Sociologists will help ensure that integrated systems augment rather than erode government, management, and organization effectiveness.

Research on the decision-making process and resource allocation in government requires the input of sociologists who study the fundamental laws of social relations and institutions. Research on information systems which increase society's capacity for centralization while pressures for decentralization are mounting requires input from the discipline of sociology. The development of increased technological capacity for task breakdown will have significant impact on professional work domains and here again sociologists provide insight into the different capabilities and workings of government and social institutions. This insight is essential to the effective development of appropriate information systems.

5. BUDGET

SOURCES OF FUNDS

The operating budget anticipated for the initial five-year period for the Institute for Information Science and Technology is based on funding from six major sources: endowment income, foundation support, government grants and contracts, industrial contract research, general contributions, and income from publications, seminars, and Resource Center services.

It is envisioned that a selected small number of major industrial organizations and foundations interested in information science and technology will be approached with a request for funds to endow the Institute. The endowment sought, $15 million, will provide a secure base of operations for the Institute, and allow core staff maximum flexibility in refining research agenda and preparing proposals for future research efforts. In the first year, an endowment of $3 million is sought, with no income available for first-year expenditures.

Initial planning and organization monies and beginning research tasks will be largely funded by grants and contracts from Federal government agencies. A total FY 1980 income of $665,000 is planned. Of this total, $399,000 has been secured as of December 1979. In addition, two government visiting scholars having a combined support cost of $140,000 are in residence providing first-year research contributions at the Institute. An additional $10,000 of government-furnished equipment has also been provided the first year.

First-Year Funding

Foundation Support	$ 50,000
Government Grants/Contracts	
—DOE	313,000
—NSF	51,000
—proposals pending	101,000
—other	75,000
Contributors	
—George Washington University	35,000
—other	40,000
Total	$665,000
Value of two Visiting Government Fellows	140,000
Government-furnished equipment	10,000
Total Research Support	$815,000

As outlined earlier in the plan of the Institute, a relatively small core staff will be employed for the management of the Institute, the preparation of proposals, and the organization and management of internal educational programs for visiting scholars and interns. By maintaining a small permanent staff and employing faculty and consultants from the many disciplines of the university, the portion of funds devoted to direct research expenditures can be maximized.

The Institute will be responsive to grant programs, requests for proposals, and other funding sources in the Federal government in order to increase research support and to address problems related to its central research programs. In instances where industrial research efforts are coincident or are closely allied with established Institute research programs, contracts will be actively sought for such research.

General financial donations will be accepted from individuals, organizations, and foundations.

Products of Institute research and development efforts in the form of books, publications, and scholarly papers will be available for sale. Income from seminars and conferences will also be realized. The Resource Center for information science and technology will generate income by providing research services to interested organizations, researchers, and the general public.

Details of the sources of funds for the initial five-year operating period are provided below. All figures are stated in 1979 monetary value and do not account for the effect of inflation.

FIVE-YEAR OPERATING BUDGET—SOURCES OF FUNDS[1]
(in thousands of dollars)

	Fiscal Year				
	1980	**1981**	**1982**	**1983**	**1984**
Endowment received (cumulative total)	$3,000	$10,000	$15,000	$15,000	$15,000
Endowment Income		$ 300	$ 1,000	$ 1,500	$ 1,500
Foundation Support	$ 50	100	100	150	200
Government Grants/ Contracts					
NSF	51[2]				
ARPA					
HEW					
Commerce					
DIDS					
NASA					
DOE	313[2]				
Others					
Subtotal	540	680	800	1,000	1,250
Industrial Contract Research			50	100	200
Contributors (individuals, corporations)	75[3]	80	50	50	75
Income from Resource Center & Seminars		5	10	20	30
TOTAL[4]	$ 665	$ 1,165	$ 2,010	$ 2,820	$ 3,255

(1) In terms of 1979 dollar value
(2) Currently funded
(3) $35 currently funded
(4) Does not include the value of visiting scholars, fellows, or interns provided by parent organizations, nor the value of government-furnished equipment

USES OF FUNDS

Expenditures during the initial five-year operating period will support a small core staff the first year, and an expansion to double the staff size in the second year. A modest increase of one added staff person during each of the next three years is planned.

Direct research program expenditures approximately double each year until the fifth, when there will be only a minimal increase.

A summary of expenses followed by a description of expense categories follows.

- *Core staff salaries:* five full-time staff (plus student assistants) for the first year, and twelve full-time staff (plus student assistants) for the second and subsequent years. Positions are as noted in Section 3, and salaries conform to the Federal Civil Service Commission maximums for related job categories.

- *Fringe benefits:* based on a fringe benefit rate of 16.5% of all salaries and wages.

- *Indirect expenses:* based on an indirect cost rate of 68%. Included in this expense category are office facilities of 2500 sq. ft. the first year and 6000 sq. ft. the second year.

- *Office furniture and equipment (purchase/lease):* office furniture, word processing equipment, typewriters, calculators, tape recorders, copy machines, projectors, and other necessary furniture and equipment.

- *Travel expenses:* funds for staff, visiting scholars, and research faculty to attend conferences and meetings, visit other research institutions, and observe demonstrations and systems developments.

- *Publications/Dissemination:* includes the development and dissemination of brochures and information announcing the formation of the Institute and the availability of positions. As research programs produce interim and final results, technical publications will be disseminated.

- *Advisory Council expenses:* based on meetings held three times a year to review research activities of the Institute.

- *Conferences/Seminars:* Institute-sponsored seminars and conference meetings to discuss research agenda, disseminate findings, and bring together scholars and practitioners to discuss research activities. As the level of research increases, the number of such conferences will increase.

- *Research staff:* the resident professional staff consists of senior fellows, senior research associates, and research assistants. These staff members represent the spectrum of experience and seniority in the field of information science and are the major research program contributors.

FIVE-YEAR OPERATING BUDGET—USES OF FUNDS[1]
(in thousands of dollars)

	Fiscal Year				
	1980	**1981**	**1982**	**1983**	**1984**
Institute Organization:					
Core Staff Salaries	$117	$ 245	$ 260	$ 290	$ 320
Fringe Benefits	19	40	43	48	53
Indirect Expenses	80	167	177	197	218
Furniture & Equipment (purchase/lease)	15	30	37	45	36
Travel	4	10	27	32	35
Publications/Dissemination	3	16	28	30	45
Advisory Council Expenses	1	15	15	17	19
Conferences/Seminars		6	14	20	25
Subtotal	239	529	601	679	751
Research Program Support:					
Research Staff[2]	60	150	335	770	820
Visiting Scholars/ Fellows	20	50	210	350	400
Adjunct Fellows/ Research Associates	125	115	285	350	400
Consultants	20	50	150	190	200
Government/Industry Interns	5	10	35	60	100
Student Assistants	10	20	32	35	35
Special Research Services	65	90	170	220	300
Computer Services	2	5	25	45	50
Research and Development Equipment	125	130	140	79	150
Other	13	16	27	42	49
Subtotal	406	636	1,409	2,141	2,504
TOTAL	$665	$1,165	$2,010	$2,820	$3,255

(1) In terms of 1979 dollar value
(2) Where appropriate includes fringe benefits and indirect expenses

- *Visiting scholars/fellows:* most will continue to have their salaries paid for by their sponsoring organization, while some will be supported by Institute funds.

- *Adjunct fellow/research associates:* staff normally not in residence at the Institute. Such researchers will reside at universities, government agencies, or industrial organizations, and serve a key role in the Institute's research plan as full-time or part-time contributors.

- *Consultants:* recognized national and international experts retained for necessary services and research inputs on particular tasks, or for the preparation of specialized reports.

- *Government/Industry interns:* includes expenses required to support the intern program. Normally the sponsoring organization will continue supporting the intern's salary.

- *Student assistants:* includes clerical, administrative, messenger, receptionist, research assistant, and equipment operator positions.

- *Special research services:* includes contracts and grants to other organizations for the conduct of certain research activities which support the Institute's programs but for which the Institute does not have expertise available.

- *Computer services:* all forms of computer services obtained when necessary and integral to the Institute's research programs.

- *Research and development equipment:* computer and terminal equipment including a medium scale computer, a three-dimensional line-drawing display, a high-resolution and a medium-resolution color raster display, several terminals and displays, a DIDS terminal, a color film recorder, a telecommunications network, and others.

This report was initially produced on a word processor and telecommunicated to a computer phototypesetter.

The color photographs were taken from a computer graphics display presentation.

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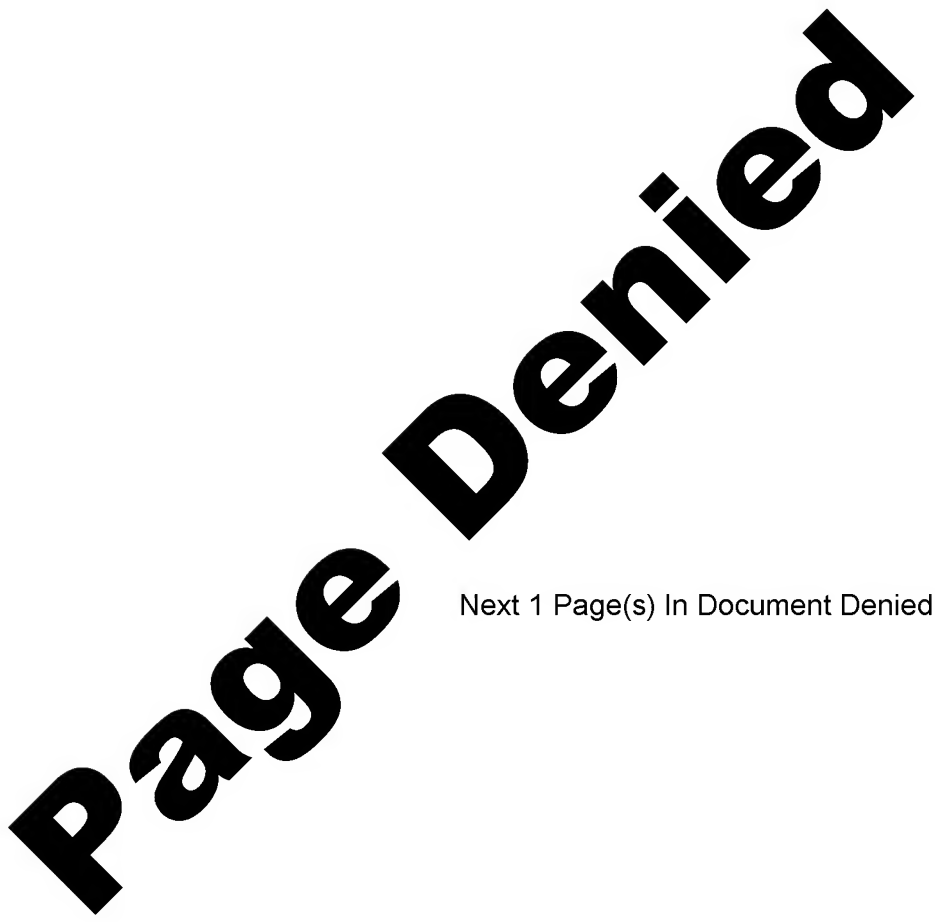

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